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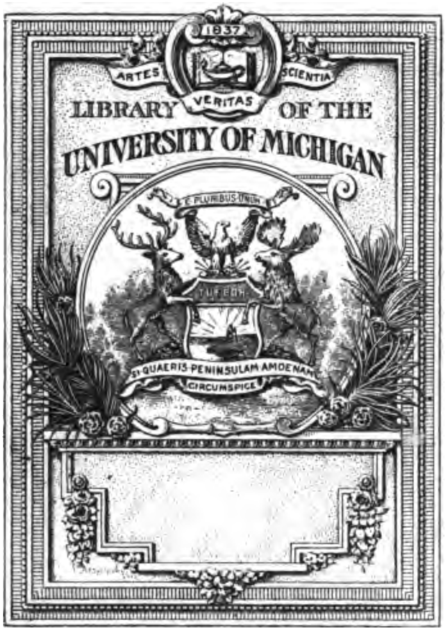

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BULLETIN
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NEW BRUNSWICK.

THE CLIMATE OF ACADIA IN THE EARLIEST TIMES.

(Annual Address by G. F. Matthew, M.A., F.R.S.C.)

Warm-Water Faunas and Cold-Water Faunas of the Modern World Contrasted.

Climate may be shortly defined as the condition of a place in relation to the various phenomena of the atmosphere, as temperature, moisture, winds, etc. These vary with the geographical position, the altitude and other conditions. We are familiar with these climatic peculiarities upon the land, but in a similar way the surrounding conditions impress themselves upon *submarine* tracts in the ocean, affecting the distribution of life beneath its waters. Thus there are submarine climates as well as terrestrial ones, and these sometimes very diverse from each other, in closely contiguous regions.

Climatic differences have existed on the globe in times past, as they do at the present day, and my endeavor this evening will be to bring before you some proofs of the variations of subaqueous climate in this part of America, in the very earliest periods of which geology has cognizance by mean of organic remains, and of terrestrial climate in the later, Devonian age.

To illustrate the past, let us take a brief survey of some peculiarities of existing climates by contrasting tropical marine life with the living beings of the northern seas; and also by observing the kinds of animals that characterize the shores as contrasted with those found in deep water.

We will thus learn what kind of creatures are suited to warm water; and on the other hand what other kinds prefer to live in the cold seas, and if we can prove by the distribution of the sea-animals in ancient times that there were areas of cold water, and others of warm water on the surface of the globe, we have shown the existence of varying climates on the land as well as in the sea; for I have only to call your attention to the well-known influence of the Gulf Stream on the climate of Western Europe, to show what effect warm currents in the ocean will produce on the neighboring land.

Certain broad features in which tropical marine life differs from that of northern seas are of a kind that might have left their impress on the animals of former geological ages, had these animals been constituted then, as their descendents are now. Such creatures, for instance, as the corals and the shell-fish (shelled molluscs), whose skeletons are composed of stony matter, would have left imperishable memorials of their existence, to show where these animals had flourished, and also to certify us of the particular kinds which had once existed on the earth.

In regard to the reef-building corals, you will notice that they are confined to tropical seas, and that even in such seas the reef builders are found at work only where the water is pure, as well as warm; thus while coral reefs skirt the eastern shores of Brazil, they are wanting off the mouth of the Amazons, and only re-appear where the Windward Islands rise abruptly from the profound depths of the Atlantic. And further, it has been found that the "coral animal" does not flourish at great depths in the ocean, but only where rocky reefs approach the surface of the sea.

Then in regard to the shell-fish (molluscs), those which exist in the ocean at the present day, are governed by certain laws of distribution, which confine some kinds to warm seas and others to cold. And further, we may note that the majority of shell-fish (molluscs) of the ocean are shore dwellers. An exception to this rule in the shell-fish is the ancient class of Lampshells, now reduced to a small number of species, but once universally prevalent, exceedingly numerous, and of great variety. This class of the Lampshells, or Brachiopods, was spread in the earliest ages both in shallow and deep waters, as they are at the present day.

The richest collecting grounds for the common molluscs are at this day found on the hot, tropical shores of the East and West Indies, and among the coral islands of tho Pacific. Here the great marine snails and bivalves are to be found in immense numbers, and are of great variety and beauty.

Coming north a marked change in the appearance of these animals may be observed; the highly burnished shells of the tropics disappear, the shell itself, as a rule, is thinner and is covered by a dull colored skin, and the great variety of species of the south is replaced by a monotonous assemblage in which, while the individuals are numerous, the species are fewer than in tropical seas, and many are small. We may therefore conclude that warm, clear seas have always been the favorite homes of reef-building corals and the marine snails and bivalve shell-fish, as we know them to be at the present day.

But while there are thus certain forms of life which flourish along shores and in warm shallow seas, the open ocean is not without inhabitants, though these in their more lowly forms are not of a kind to attract attention; yet owing to their immense numbers their skeletons have been of great importance in building up the layers of the earth's crust.

Among these lowly forms are the Foramenifera, the great majority of which are very small, and many so minute that they cannot be seen without a microscope. Animals of this kind constitute the bulk of the English chalk, and are now being showered down in countless numbers on the bottom of the sea, in its warmer parts. The mud which covers the submarine plateau in the North Atlantic, where the electric cables are laid, is largely composed of the shells of Foramenifera, some large enough to be seen with the naked eye, others invisible.

Another class of these low organisms of the ocean is that typified by the Sertularian Zoophites. These little creatures live in colonies attached to the "gulf-weed" which floats on the surface of the Atlantic. The gulf-weed is a kind of sea-weed (*Sargassum natans*) which floats on the broad surface of the Atlantic, south of the Gulf Stream; it is so abundant in some areas as to conceal the surface of the sea itself. These tracts of the ocean, undulating with every billow, have been compared to vast pasture fields. Such a tract is the Sargasso Sea: uch another is found in the Pacific Ocean. The imagination would lead one to think that these weeds must seriously impede navigation; and it was in this sea that the sailors of Columbus became so much alarmed, that their commander had great difficulty in persuading them to continue their voyage.

The gulf-weed harbors a minute world of its own; here we find little crabs crawling about, and other minute crustaceans take shelter under its branches. Small fish may be seen to harbour in the weeds, sheltered there from their enemies, as they would be in the weeds that still grow along the shores of the sea, or in the rivers.

Another class of little creatures which are found in the open ocean are the Pteropods, or, as the French call them, "Butterflies of the Sea." They are so called because their organs of locomotion consist of two little fins, or membranaceous appendages, which are kept in constant motion. In the rapid flapping of these little fins, they resemble butterflies on the wing. These small creatures are protected by a thin, translucent shell, usually of a conical form, but sometimes spiral, or sack-like.

All these are animals which live and reproduce their kind in the open ocean; but there is another class of animals, many of which are found in the deeper waters and which also reproduce at a distance from the land, but in their adult state are of much greater size and live upon the bottom of the sea; these are the sponges, an order of which the Euplectella, or glass-sponge, may be taken as an example. This animal is found in the China Sea and other closed seas of the Pacific Ocean.

Thus we see in contrast two groups of animals — those that inhabit the warm shallow seas and those that may be found in the deeper and colder parts of the ocean. The forcing of marine animals into special associations shows thus the existence of water of different temperature in the ocean, just as we have the more familiar climatic differences that modify the association and distribution of animals over the surface of the land.

As there are now tracts in the ocean occupied by waters of different temperatures, so there were in the earliest Palæozoic times, and this is shown by the remains of marine animals entombed in the rocks. In certain regions are found the remains of the coral building forms and the molluscs, which correspond to those of the warm, shallow seas of the present day; in other regions, as in the confines of this city, and at various points in the Maritime Provinces, are entombed the remains of animals corresponding to the Sertularians, the Pteropods, the Glass-sponge and other forms of the open ocean.

THE ABYSSAL CHANNELS OF THE OCEAN.

The prime cause of climatic differences, for the earlier ages of geological time, is to be sought in the action of the sun's heat on the surface of the globe ; and can be traced by its influence on marine organisms, because we know of no land animals or plants in the earliest ages.

The explorations of the Challenger and other vessels sent out to measure and explore the depths of the sea, have shown that there are enormous areas of the ocean where the depth is from 2,000 to 4,000 fathoms. If we estimate the average level of the land surfaces at 1,000 feet, as Dana has done, and bear in mind that the surface area of the land is only a third of that of the sea, it will be clear that if this land were flung into the ocean it would go but a short way to filling it up. The sea, in fact, would roll above it two thousand fathoms deep.

We are told that there was a time when the "earth was without form and void," and in view of the apparently artificial or unnatural way in which the continents are bolstered up, it seems not unreasonable to suppose that there has been a time when all these lands were buried beneath the ocean, and that the earth was actually thus formless. But in the earliest times of which we have any knowledge through geological evidences, some portions of the land was above the sea, and continental or emerged areas existed. How, then, were those lands sustained above the ocean? What was this mysterious power which for uncounted ages kept these lands with more or less completeness above the sea, or at least above the deep abysses of the ocean. The rains, the frosts, the winds and the transporting power of rivers have been ceaselessly at work through uncounted ages levelling down these continents, but have not destroyed them. There must be something in the physical constitution of the globe itself which maintains them. The abysses in the ocean themselves offer the explanation of the phenomenon, for they have been found to be the channels by which frigid waters from the poles reach the tropical regions.* These bottom waters would convey away heat from the earth's crust immediately beneath them, rendering it rigid and immovable, and fitting it to perform the duty of a buttress to the border of the continent adjoining. The resulting action would be that in any movement of the crust which might occur while the continental borders would rise by expansion, the adjoining ocean abysses, as they became colder and more rigid, would have a tendency constantly to become deeper. Thus in these ocean depths there have been established *rivers in the ocean* complementary to the surface river — the Gulf Stream and other warm currents—of which Maury wrote in his work on the Physical Geography of the Sea. Thus it has come about that in the border lands of this continent there has been for ages a fluctuation between the influence of the warm seas to the southward, bringing in a tropical and shallow-water fauna, and the frigid waters of these submarine rivers, carrying northern species from the Arctic zone to temperate latitudes.

The region in which we live, at a point half way between the equator and the pole, has, stowed away in its rocks, the record of the prevalence at one time of warm-water faunas, at another of those to which the cooler water of northern seas was more congenial. But the warm-water faunas are of rare occurrence compared with the cold-water faunas.

VOLCANIC OUTBURSTS IN PRE-CAMBRIAN TIMES.

The dawn of the palæozoic ages was ushered in in many countries by grand volcanic outbursts. Such was the case in Great Britain, where vast sheets of lava and ashes are found beneath (and included in) the Cambrian rocks. Such, also, was the case in Norway, where the lava streams continued to flow in Cambrian times. Such was the case, also, in our own country, where the Carleton Heights, on one side of the harbour, and the Loch Lomond and Quaco Hills on the other, testify to the activity of volcanic vents near St. John in those early times. And it has recently been discovered that a similar substratum of volcanic deposits underlies the Cambrian rocks in Pennsylvania and southward.

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* In the ocean abyss, just eastward of the Windward Islands, in the West Indies, the lower layers of water are very little above the freezing point, but westward of hese islands, in the Carribean Sea, the surface temperature exceeds 80°.

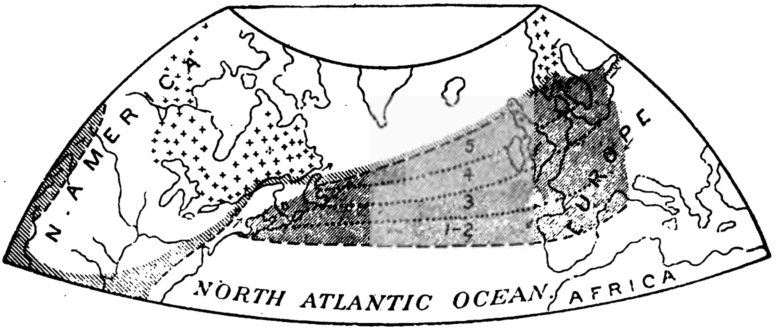
In nearly all countries where we know of the presence of Cambrian rocks, this time of volcanic activity was followed by the appearance of a warm-water fauna, as though the volcanoes themselves, either by the heat they liberated, or by their effect on atmospheric phenomena, had sensibly influenced the temperature of the sea. This warm-water fauna (or warm and shallow-water fauna) is found wide-spread along the base of the Rocky Mountains, has recently been discovered in the southern Appalachian range, and existed also in the St. Lawrence valley and near St. John.

On the other side of the Atlantic it has been found in the west of England, in the north of Scotland and in Norway and Sweden.

In these latter countries it was superseded by the Paradoxides fauna; whose origin we know not, except that as it was borne from Europe to our shores, its fountain head would seem to have been the Arctic regions of the Old World. This is the best known fauna of the St. John group; it came to us on the cold current from northern Europe, but so far as we know was never able to pass the mountain barrier of eastern North America, or establish itself in the interior of the continent.

After spreading itself along these Atlantic shores, changes supervened, which brought in a new fauna in the colder seas. The cause of this change is unknown, but it was accompanied by a rising of the land here, as well as in Wales and France. When the land sank again, we find that the northern seas were in the possession of a new group of animals, the gigantic Paradoxides had disappeared, and the Oleni, little crustaceans, many of them not larger than a filbert, had taken their place.

SKETCH MAP SHOWING THE DISTRIBUTION OF ANIMALS IN LOWER CAMBRIAN TIME.



+ + + + + + Canadian Laurentian Continental Nucleus and the "Fundamental Gneiss" of the west of Europe, these ares are supposed to have been emerged land in Cambrian time. Other smaller areas on the Atlantic coast of America and in France and Germany are not represented. The "deeps," or abyssal areas of the ocean, skirt the border of North America about 100 or 200 miles from the coast, except along the Newfoundland shore, where the deep waters are thrust out a distance of 400 miles by the "Grand Bank."

↗ ↗ ↗ ↗ Outcrops of rocks containing the Olenellus fauna, an assemblage of Cambrian animals found mostly in warm shallow seas. Three outcrops in the Rocky Mountain region and four in the Appalachian region in America; outcrops also in Scotland, Norway, Sweden and Russia.

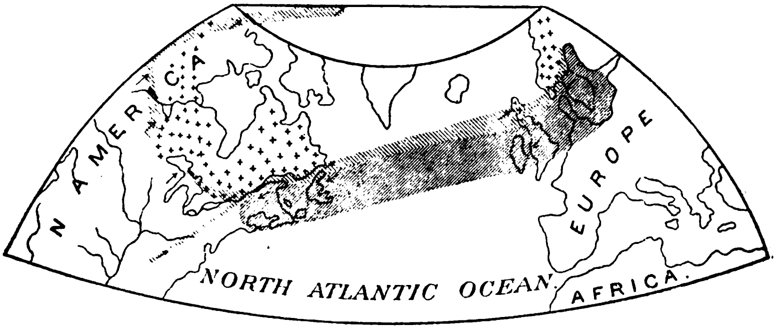
↙ ↙ ↙ ↙ Outcrops of the Paradoxides fauna. Five sub-faunas are distinguishable occurring in chronological sequence, the complete series known only in Sweden, which, therefore, was nearest the origin or centre of dispersion of the fauna, and had the physical conditions of temperature, etc., best suited to its propagation.

CAMBRIAN FAUNAS OF THE INTERIOR SEA AND OF THE ATLANTIC BASIN.

Meanwhile there had been growing up in the interior of America a fauna of an entirely different type. There the warm seas had nourished crustaceans of genera differing from those of the Atlantic coast; and the molluscs had shown themselves capable of variation in several directions. On the one hand Maclureas presented themselves as one of the most important early developments of the sea snails, and various forms of Orthocerata showed the early phases of the class from which the Nautili subsequently sprang. These forms were borne on the warm waters which laved the eastern shores of the North American continental nucleus, from New York to the Strait of Belle Isle, and its western shore from Manitoba to Boothia Felix and Grinnell Land, thus reaching Europe by the circuitous route of the Arctic circle. Shallow waters and warm currents enabled these shells born in the Mediterranean of America to penetrate to the pole itself, and this before they had been able to invade the chilled waters of the Atlantic coast. However, we should remember that the continental lands were then probably of less extent than now, and the earth's atmosphere denser, conditions which would favor a more uniform distribution of heat over the earth's surface and enable the animals of the tropical seas to invade the Arctic circle.

While these early sea snails and straight nautiloid forms had been growing up and developing in the warm seas of the interior, another type of beings had been fitting themselves to the very different conditions of existence in the North Atlantic. These, the Graptolites, were roving creatures, fitted to propagate their kind in the open sea. Through the subsequent ages we find them gradually simplifying their structure, so that the colonies of many branches of the earliest times are reduced at last to colonies of one stem without a branch, and with rows of cells on one side of the stem only. In modern times we have the Sertularians, branching colonies of minute creatures as representatives of the Graptolites. In

Sketch Map showing the Distribution of Animals in Lower Ordovician Time.



+ + + Areas of Laurentian rocks as in the preceding map.

↗↗↗ Outcrops of the Chazy fauna, found chiefly in limestone rocks, and areas of sandstones supposed to be of that age. Corals and numerous forms of molluscs appeared at this time, and the fauna is supposed to have flourished in shallow, warm seas.

↙↙↙ Outcrops of the Arenig fauna The rocks of this fauna are, to a large extent, mud rocks, with thin flagstones, and the fauna is supposed to indicate the prevalence of colder and deeper waters than those of the Chazy fauna. Since the above map was drawn I have learned that the Arenig fauna has been recognized in the south of France ; if this region were included in the Arenig area, the shaded portion of this map would correspond almost entirely with that of the map on page 11.

Compare the range of the faunas represented on this sketch-map with those of the preceding. The upper Cambrian faunas are intermediate between the two faunas represented on these maps.

a previous part of this address I have spoken of these zoophites as growing upon the gulf weed that floats in the mid-Atlantic, but they are found also in shallower water.

The king-crabs and other modern crustaceans were represented in ancient times by the Trilobites, of which some species were fitted for the deeper seas and others for shallow waters. The trilobites were the most highly developed crustaceans of that early time. The Glass-sponge, which has been spoken of as an inhabitant of deep still seas, had also its representative in Cambrian times in the Protospongiæ, Cyathospongiæ, and other sponges with six-rayed spicules.

The contrasted faunas or groups of animals of the warm shallow seas and the deep cold seas in this part of the world, lasted through a long period of time, so that throughout the Cambrian and Ordovician ages there were along the Atlantic coast of North America, as well as in many parts of Europe, extensive tracts of cold sea water, more or less charged with fine mud, that supported the second group of animals I have spoken of; and over the central parts of North America, and subsequently in Europe, there were wide areas of the ocean, shallow and warm; here flourished the corals, nautiloid shells and sea snails belonging to the first named or warm-water fauna.

Time, however, brought changes. The marginal areas of the continent were elevated, and in the Silurian time the cold-water faunas had but a precarious footing in many parts of the eastern provinces of Canada.

Both at the opening and close of Silurian time, if not throughout its whole extent, lava-flows and discharges of volcanic ashes occurred in various parts of Acadia, as preliminary, perhaps, to the appearance above the water, of large tracts of land which are found to have existed here in the succeeding geological age — the Devonian.

Climate of Acadia in Devonian Times.

Another aspect of our climate was now ushered in. No land plants are known to have existed on the shores or in the interior of this region in Cambrian times, and this would lead us to suppose that the land was bare of vegetation; but a very different state of things prevailed in Devonian times, for in various parts of eastern Canada remains of land plants of the Devonian age have been found. Without going into the minutiæ of the physical changes which passed over the land during the whole of the Devonian age, let us note the conditions of things here at a time which is supposed to have been in the middle term of the Devonian.

The border of the continent was then far off to the eastward of New Brunswick. Extensive ridges throughout eastern Nova Scotia and southern New Brunswick were covered by a vegetation, almost the first land vegetation that we know of. A few rare plants of greater antiquity are known. Remains of such have been found in the hills of central New York and Pennsylvania, and latterly in the sandstones of Wales. These are of different species from our Devonian plants, but have a general resemblance to them.

The Devonian vegetation of the Maritime Provinces of Canada consisted largely of plants similar to those which prevailed over extensive areas in Europe and eastern North America during the coal period. They grew in extensive swamps or flat low-lying tracts of land. Ferns and calamites were plentiful, a proof that a moist climate prevailed. Fresh water crustaceans and the larvæ of neuropterous insects are found, and so we suppose there were ponds in these marshes; and further than this the insects which flew through these thickets and bracken were related to the dragon flies and the may-flies, which at the present day delight in the borders of marshes and streams. The beds which form the St. John basin of Devonian rocks are thickest and coarsest to the eastward, and we suppose that from that direction came the river which bore down into the estuary near St. John, the sand-

and mud which subsequently became the solid rocks of the Devonian age.

The belief that the rings of growth in trees mark the alternate periods of growth and repose which the returning seasons bring to vegetation is not altogether dissipated, though it has been attacked. Such a view of the source of these annular rings has been called in question of late years, and it has been stated that these rings are found in trees that grow in tropical regions, where there are no changing seasons. And further (that on testing the question by noting the number of rings in certain young trees that have been made the subject of observation) it has been found that these rings are more numerous than the actual known years of the life of the tree.

We should remember, however, that within the tropics, while there is no winter and summer, as with us, there are in most parts of that great belt of the earth's surface certain seasonal changes which, in their effect on vegetation, are similar to the alternations of the seasons which we enjoy. In some parts of the tropics there are two seasons in every year, in others four; but in either case the trees would be alternately stimulated to rapid growth, or left to mature the wood and fruit whose growth had begun in the rainy season. At the present moment (January) the woods on the uplands and mountains in the West Indies are as brown and bare of leaves as our own hardwood forests.

Admitting, then, that these annular rings do indicate seasonal changes, let us examine the condition of the logs which may be found buried in the Devonian sandstones of our city, to see if they exhibit any proofs of changing seasons of the kind alluded to above. These logs occur in the lower part of the formation, or terrain, and are often found in clusters, as though they were parts of broken rafts that had been ground and worn in their transit by water from the interior of the country, before they were buried in the sands of the bars along the course of the river, or at its mouth.

When cut across, these trees show distinct annular rings of growth, proving that the plant had alternate periods of rapid and slower increase. They had very large pith-cylinders as compared with those of our living coniferous trees; these cylinders are sometimes as much as an inch across; and if the large pith had the same significance as it has in modern plants, the trees had a rapid growth.

The microscope reveals a beautiful structure in the Devonian trees. Side by side lie immense numbers of little cells, which went to build up the trunk of the tree, and each of these cells carries a number of pores along its walls, arranged in several crowded rows, running lengthwise in the cell. Even with the naked eye one can see the medullary rays that radiate from the pith cylinder to the outer surface of these old Devonian trees. Thus in these trees entombed so many ages ago you may see the whole economy of structure of the trunk as we have it in modern trees, the central pith so important, especially in the early growth of the plant, the vascular or woody tissue, of which the principal part of the trunk was composed, and the medullary rays that serve to unite the centre of the tree with its periphery, and portions of the bark that once enveloped the whole.

Such are the morphological conditions of the tree; but you may also in these trunks study the effect of dynamical and chemical action in rending apart the layers of the tree and filling the space with a wedge of calcite, or else in replacing the substance of the wood by a siliceous deposit. But this is apart from our subject, which was to show by the mode of growth in these trees that the earth at that early period of Devonian time possessed seed-time and harvest, if not summer and winter. It is true that man did not witness this sowing and ingathering, but he may still glean of the harvest and pick up the spare seeds that escaped the germinating influence of the Devonian soil.

This smiling Devonian country, covered with vegetation and teeming with life, existed but for a time. Rougher conditions supervened, the sandy beds became coarser, and fewer plants were preserved. Finally the sea swept over it and destroyed its verdure. Great rugged hills rose in the interior, and from time to time, here and there in the neighboring country, volcanoes, emerged and submarine, poured out their lava, ashes and mud over the surrounding tract. The forest and fern growth was swept away, not to return until the Carboniferous age.

It would tire you were I to attempt to draw a sketch of the physical condition of this region in later geological time, or to indicate the climatic changes that have supervened, but those which I have hastily sketched for the Cambrian and Devonian ages may interest you, as they are attested by rocks which underlie your city, and proved by the animal and plant remains its rocks contain.

ARTICLE I.

NOTES ON THE GEOGRAPHY AND NATURAL HISTORY OF THE TOBIQUE.

BY GEOFFREY STEAD, C. E.

The Tobique Valley seems to be a "terra incognita" to many people in St. John and the southern part of this province. From a summer's stay on the river, I am able to give a short account of its Geography and Natural History.

The Tobique is one of the larger left-hand branches of the St. John, having a basin of 1,500 square miles. It enters the latter river about twenty miles below Grand Falls, and nearly opposite Andover. Its course for the lower twelve miles is about westerly, above which it bends nearly parallel to the St. John, so that after ascending the Tobique twenty-five miles we are nearer Grand Falls than at the mouth of the river.

The course of the valley of the Tobique beyond the lower twelve miles is, though very crooked, about north-north-east till the Forks are reached — fifty-four miles from the mouth. Here the river divides; the two branches shortly sub-dividing to form four large streams. The chief of these — the right hand branch — rises in several large lakes, draining parts of Northumberland and Victoria Counties, and flows north-westerly to the Forks. The left branch, or Little Tobique, rises at Lake Nictor, in Restigouche, quite close to the head-waters of the Nepisiquit.

The course of the river at the Forks is peculiar. The two branches come together from different ends of the same valley. There is a sudden break in the ridge which forms one side of the valley, and through this the waters escape which form the main river, flowing in a course at right angles to the direction of the branches.

Riley Brook, a few miles below the Forks, is the last Post-office ascending the river, and a short distance above this, settlements cease. Extensive lumbering operations are carried on on the branches of the Tobique, which are ascended by canoes, and during freshets by flat boats, towed by horses. On this upper part of the river are some of the finest salmon and trout fishing-grounds of the province.

Plaster Rock, twenty-six miles from the mouth, is the present terminus of the Tobique Valley Railway, and from here down I can bear testimony to the great beauty of the river scenery.

The main Plaster Rock is a cliff about 130 feet high, standing on the left hand or eastern side of the river. It is chiefly of a reddish color, the gypsum not being quite pure, alternating with thin layers of white fibrous gypsum. On the opposite side of the river the plaster is not so distinct, the layer is thinner, limestone forming most of the bank. The bank is more sloping and bushy on this side, but the set of the stream on to the eastern shore keeps a fresh surface exposed there. Every spring large masses fall, loosened by the action of the frost, and being friable in time disappear.

About two miles further down on the same side is another exposure of gypsum separated from the river by a small interval. The chief supplies have been drawn from this lower rock, and many thousands of tons removed, but it has made scarcely any perceptible impression on the mass.

Just below this lower rock, the Wapskehegan, the most important tributary of the Tobique, enters. At the mouth of this branch, the Tobique takes a great bend, enclosing in the semicircle a beautiful flat, well cleared, back of which the land rises hilly and wooded.

The river next passes steep banks and bluffs, many of them quite changed now by the railway embankment passing along the face. Then flats—lands which make good farming tracts. Then there are bluffs and hills again, covered with second growth of poplar and white birch.

Odell River, an important lumbering branch, which enters about seven miles below Wapskehegan, is the next large stream. Its waters rise within a mile or two of the southwest Mirimichi.

On the opposite side of the river is Arthurette, the nearest approach to a town, on the Tobique, for the original eighty rod lots have in some cases been subdivided in passing from father to children, so as to leave only a narrow strip with each house.

The Arthurette Flat is one of the most extensive on the river. A "bogan," or back-water creek, runs for some distance behind the flat, and a large peat bog is found there also; both good collecting grounds for the botanist.

The Red Rapids commence a little below Arthurette, and within a couple of miles are several low falls caused by ridges of red conglomerate rock crossing the river at these points.

A couple of miles below Red Rapids the alluvial land ends. High banks and precipitous rocks encroach on the river from both sides until we reach the valley of the St. John.

The last mile of this passage is called the "Narrows." Here the river rushes through a narrow rift in the rocks, which rise on each side about one hundred feet. In spring the rapids are a fine sight, and when the water is at its height, impassable for boats or rafts.

GEOLOGY.

The geological structure of the Tobique region consists primarily of a basin of Lower Carboniferous rocks in the midst of a large tract of the Silurian age. Along the southern border of this tract masses of granite appear, flanked by belts of pre-Cambrian and Ordovician.

The Silurian region includes the whole of the north-western part of the province, with the adjacent parts of Quebec and Maine; but in places its strata are overlaid and concealed by rocks of newer age, such as Devonian or Lower Carboniferous. It forms the "fertile belt" of New Brunswick and north-eastern Maine. The river St. John occupies a depression in these strata, or, as at Grand Falls, has cut a channel through them. The river valley is now in great part occupied by terraces, which form such a conspicuous part of the scenery of the upper St. John.

These terraces continue for about a mile up the Tobique, ceasing for a short distance at the Narrows, where the river has cut its way through a high Silurian ridge, which here has barred its course to the St. John. The rocks consist here, as elsewhere in the Silurian tract, of calcareous slates with thin bands of limestone, all of which, through great bending and contortion, stand almost vertical. In the limestone, fossils of Silurian age have been found. Elsewhere plant remains have been found, which are thought to be of Devonian species, an evidence that the Devonian is also included in the Silurian region, though it is separated with difficulty from true Silurian strata.

The ridge just mentioned as situated near the mouth of Tobique, attains a height of 1,200 feet a few miles back of Red Rapids. The crumbling calcareous slates produce a rich soil, and where the hills are not too steep, it makes a fine farming country. Several settlements, as Birch Ridge and Scotch Settlement, have already sprung up here and are thriving.

About Red Rapids we come to the outskirts of the Lower Carboniferous outlier of Victoria County, already referred to, which occupies a depression in the Silurian. It has a maximum width of twelve and length of twenty-seven miles, its length being in the direction of the river valley.

The beds have a slight dip towards the north, and therefore towards the centre of the basin, so that in travelling up river we see a section of the formation.

Skirting the upturned Silurian rocks are coarse red conglomerates and sandstones, the successive ledges of which are well seen in ascending Red Rapids. Above the rapids for some miles no further outcrops appear along the river, for its banks are occupied by terraces and alluvial flats, but on the slopes of the surrounding hills the same beds appear through the soil.

The Lower Carboniferous in this district is not found at any considerable elevation except at Plaster Rock and perhaps Blue Mountain, and the hills over this formation are generally kames or gravel ridges except Blue Mountain, which is of volcanic origin, and Plaster-Rock ridge.

Passing on up river we come at Black Rock to further outcrops. The rock is here not so coarse in structure, consisting of red and grey grits with thin beds of red and bright green shales.

The grits would make a good building stone and are traversed by joins which produce natural blocks, though these are often too small; part of the beds split into wide sheets which might be used for sills or flagstones.

The sandstones now get softer and more calcareous. A railway cutting a mile and a half below Wapskehegan shows them well. They are here beautifully coloured in shades of grey, purple and red. The shales also increase in thickness, one green band being over a foot thick. They quickly crumble on exposure to the atmosphere.

Just below Wapskehegan we come to still higher beds of the same series; here limestone ledges stretch out into the river and are covered by the water during freshets. Above the limestones are fine sedimentary beds with red and white layers, which rise perpendicularly out of the water to a height of fifteen feet. From the regular facing of the cliff on the river and the somewhat level top, it goes by the name "Tom Day's Wharf," called after a well known character in the neighborhood.

Above this on the bank are limestones partly compact and crystalline and partly having a conglomerate or nodular structure, and with them layers or masses of olive green shales.

The limestones show no trace of animal remains, and would seem to be a chemical deposit and not formed as those of Windsor, N. S., and other localities, principally from the relics of sea life.

These limestones and shales are seen cropping out for two miles at least further up river and underlie the gypsum. This I have before described as exposed just above the mouth of the Wapskehegan. It here forms a cliff not more than thirty or forty feet high, but becomes much thicker at the main Plaster Rock, which rises perpendicularly to from eighty to one hundred and twenty-five feet.

About one mile and a half back of the river at Plaster Rock is the so-called Plaster-Rock Ridge, a long, level ridge with rather steep ends and sides. It stands considerably higher than the "rock," and is prominent in the view from far down the river. It is composed, according to Dr. L. W. Bailey, of conglomerate, forming the highest member of the Lower Carboniferous series of Victoria County. Between this ridge and Plaster Rock are numerous sink holes, caused by the solvent action of water on the gypsum beneath. Two mineral streams join the river near the rock, they are weak solutions of Epsom or some such salt.

About two miles further up river I noticed red cliffs, probably of red sandstone. My remarks on the geology of the district beyond this point are borrowed, chiefly from reports by Dr. Bailey and Mr. R. Chalmers, of the Geological Survey.

Trap rocks usually occur with the first and last beds of the Lower Carboniferous. On the Tobique they have been noticed near the ends of the basin, on the Otelloch Brook at Red-Rapids Bridge, and at Blue Mountain, which is at the northern limit of the formation. They are supposed to be contemporaneous with the newer and higher beds of the series.

Beyond the carboniferous basin the river and its tributaries run through a Silurian area, the northern and western branches passing only through this formation, while the southern and eastern branches rise among older formations in highlands which form the watershed between the Miramichi and Nepisiguit. At the head of the Wapskehegan and Gulquac rivers rocks of the Ordovician System appear, as well as on the right hand branch of Tobique. The rock consists of feldspathic sand-stones and quartzites, with hard, blue slates.

These in turn are succeeded by highly metamorphic rocks, felsites, syenites and schists, of supposed pre-Cambrian age. They are seen about four miles above the mouth of the Serpentine and in the region of Long and Tobique Lakes. Long granite belts penetrate this region, parallel to the great granite axis which runs north-easterly through the counties of York, Carleton, Northumberland and Gloucester. One of these belts intrudes on the pre-Cambrian, crossing the Serpentine River. At Long Lake the junction between granite and the pre-Cambrian is well marked by boulders, though rock in situ is not seen. Granite boulders are strewn thickly over the upper part of the lake, while the rest is occupied by boulders from pre-Cambrian rocks.

This watershed region is generally 1,000 to 1,200 feet above sea level, but some of the many hills rise considerably above this, as Bald Mountain, on the south branch of the Nepisiguit, and Bald, or Sagamook Mountain, near Lake Nictor, both of which are 2,500 feet above the sea.

The geology of the district is very difficult to study. The country is covered with drift material and forests, which conceal the underlying formations almost everywhere. Again, the rock is greatly altered, stratifications obscured, and the folding and crumbling of the beds and injections of volcanic and granite masses have further confused the structure of the region.

Many of the characters of the whole Tobique region are explained as results of the so-called "Devonian Revolution." This geological disturbance resulted in the crushing and folding of the Silurian and Devonian systems against the older formations which had previously been raised and solidified.

Great masses of granite were extruded during the disturbance, the granite of the Nerepis Hills and Spoon Island (St John River), and also of the great central belt of the province, being supposed to date from that time. The Cambrian and other rocks of St. John city shared in the disturbance. Indeed it has been said that New Brunswick owes her chief physical features to this revolution, some of her highest hills and ridges, and the basins and hollows where later deposits have accumulated. It was the last great movement of the kind New Brunswick experienced; for throughout the province we see the beds of the next formation—the lower carboniferous—almost as level now as they were when deposited on the ancient sea bottom.

I have mentioned before terraces near the mouth of the river. Above the Narrows they are again to be seen, and here much higher, being as high as forty feet and over, as if during the glacial period the Narrows had been blocked with drift and the river converted into a lake; and in support of this idea we notice in ascending, that as the river rises the height of the terraces above it decreases. But it is generally to be noticed that when the river valley is wide, terraces are extensive and low, while when the valley is contracted they are narrower and to be found at higher elevations.

Above the mouth of the Otelloch Stream the railway cuts through an alluvial bank, a spur of a terrace, and giving a section of the surface deposits, extending back from the place. The railway rests on a bed of light colored clay, above which in the section is a layer of dark loam, a foot or two thick, abounding in plant remains, grasses, twigs and stems of plants, and through part of the thickness remains of small beetles were common. Above this are ten feet of red gravelly clay, very springy (for water cannot get through the pure clay below) which caused a great deal of trouble in excavation. These beds have a decided dip up river which is especially noticeable on account of the dark layer.

In the high bluff above the mouth of the Odell River, beds of gravel and sand, with boulders, dip down stream at angles of about forty-five degrees. This is perhaps due to a ridge of rock in the centre of the hill, below which gravel and sand carried over by the current would necessarily be deposited at an angle. Just above are horizontal beds of fine sand. On account of the high inclination of the gravel beds, railway ballast was hard to obtain, for it seemed to occur in pockets, and at no place could more than two cars be loaded at once; and it was the same in most of the bluffs cut into along the line of the railway.

Mr. Chalmers speaks of terraces as occurring all the way to the Forks, and up the Nictor Branch, where they get higher as Lake Nictor at the head of the river is approached. The lakes at the heads of the branches are results of glacial action, for the hollows they occupy were, before the glacial period, supposed to have been filled with disintegrated rock. Glaciers scooped this out and dammed up the hollows with drift. Lake Nictor, Long and Tobique lakes, and others, were formed in this way.

There is strong reason for believing that Lake Nepisiguit formerly discharged into the Tobique, but was dammed by drift at its southern end, and forced to empty its waters by the Nepisiguit into Bay Chaleur.

BOTANY AND ZOOLOGY.

I had very little time to give to the botany of the district; where possible I pressed specimens of the rarer kinds of plants. One of these—*Aster corymbosus*—is not mentioned in the last New Brunswick list.* Some of the others had not before been reported from this region.

I outline the chief habitats met with, with some plants noticed in each.

First.—The Hard Wood Ridges — notably those of Birch Ridge and Leonard's Settlements, back of Red Rapids. Birch, beach, and maple, are the commonest trees, they grow to a large size and afford valuable timber. There is no thick undergrowth in these woods though the ground is carpeted with green plants—ferns, trilliums, etc.

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* Mr. G. F. Matthew, however, had collected it near St. John.

The road from Perth passes through such woods in what is called the Gulch—a beautiful ravine with a rapid stream flowing down the centre and high and steep hills on either side. I found here the Maiden-hair, but this fern does not seem to extend up the Tobique.

This land when first cleared yields wonderful crops. Oats are usually the first planted, and grow up rank and luxuriant, yielding an immense amount of straw as well as a large increase of grain.

In hollows and beside streams flowing between these ridges, hemlock and spruce are more common, and are extensively lumbered.

Second.—Rich hills and slopes along the river valley, burnt over and since grown up with poplar and white birch, with sometimes a greater variety of trees — cherry, fir, spruce, etc. Here grow the two coral roots, the *Goodyera repens, Smilacena racemosa,* and numerous other plants. This includes a large part of the land bordering the river.

Third.—Borders of intervals and meadows. Here we find fine elms and poplars and a thick margin of alders, in the shade of which the ostrich-fern and wood-nettle grow abundantly. The agrimony is very common in more open ground. Hazel is more abundant on the borders of the higher meadows.

This bordering of trees and shrubs affords great protection to the lowlands of the river plain from the ice and currents.

Where intervals have not been cleared, the flora is far richer, containing besides the last mentioned species, large ash, spruce, fir, and hemlocks, with the Indian turnip, the larger coral root, wild ginger, blood root, etc. At the mouth of the Wapskehegan is just such a luxuriantly clothed interval.

Fourth.—The peat bogs, sometimes covered with small dead tamaracs, sometimes grown over with cedars. Bogs bordering on lakes are usually covered by heaths, such as sheep laurel and andromeda.

In a bog of the first mentioned kind, at Arthurette, there grows an immense number of the *Cypripedium spectabile,* our most beautiful lady-slipper, which was one of the first orchids brought to England, when an interest began to be taken in the cultivation of the plants of this order.

Also the yellow lady-slipper, the Arethusa—*A bulbosa*; a small lily—the *Tofieldia glutinosa.* The wild calla, *C. palustris* grows in very wet places, as where streams run through a bog.

Fifthly.—The Bogans. This word *Bogan* I have only heard used on the Tobique; it means a back-water creek such as are common among intervals and lowlands on the St. John and all its tributaries. In these muddy and stagnant creeks grow the common and the smaller yellow water-lilies, the water crowfoot and the bladderwort.

Among other plants noticed on the river is the curious strawberry blight, with its large heads of soft, juicy flowers, which I found in the burnt railway clearing through a grown-over swamp. A resident of the Tobique told me it is called Indian paint, and that it is used by the Indians to stain their baskets. On my way up the Tobique I saw numbers of the beautiful purple clematis in bloom along the St. John, from Woodstock to Perth, but on the Tobique none could be seen.

The butternut, common on the St. John, does not ascend the Tobique, and the same with the oak.

The hemlock, I have been told, does not extend more than twenty-five miles up the river, or at least does not grow abundantly above that distance.

Botrychium lunaroides, an uncommon plant about St. John, grows very commonly on the Tobique. *Botrychium matricariæfolium*, a rarer species, also occurs.

Several species of land snails were collected. Of fresh water clams I only saw one kind in the river, and that a common one. The river snails, except a couple of small species, are common on the St. John River, even as far down as Kennebecasis bay.

Lymnæa catescopium is more abundant on the lower St. John, but I never found such large specimens of it there, as on the Tobique.

Among land snails, the very small kinds are in the majority, especially on the rich intervals where they are common, and easily found sticking to decaying drift-wood, bark and leaves. On the hard wood ridges some larger kinds live. These are to be found under old logs, sticks, and leaves. The largest of those shells, the *Helix sayii,* looks quite plain when deprived of its occupant, but the body of the animal is beautifully marked with brown spots and bands which show through the translucent shell, and give the creature when alive a beautiful appearance. It is uncommon about St. John, but abundant where I found it on the Tobique.

The birds of any region are apt to attract notice, and though not a student of ornithology, I could not help observing the commoner and larger kinds. A large fish hawk made his beat as regularly as a policeman up and down the river at Red Rapids. I often watched him, but never happened to see him catch a fish. Wild ducks were very abundant on the river, and are not troubled by the natives. A brood were reared on an old pier just opposite one of my boarding places, and this pier they had used for several years. Occasionally, a heron or marsh hen is also to be seen. The moose bird, familiarly called Joe Goddard's Ghost, after an old lumberman, is always seen hovering round the lumber camps; and I notice it sometimes mistakes the Tobique houses for lumber camps, and hovers around them too. It is a very tame bird· When I have been using level or transit, it has stood about in picturesque attitude as though it expected me to take its photograph. I saw where a pair had their nest in the top of an old tree trunk, too high to examine. Its more beautiful and more noisy relative, the blue-jay, is even commoner, and its harsh note often disturbs the quiet of the country roads. Partridges are abundant and tame. I saw one killed by a stone after a dozen had been thrown at it without its moving. They used to be more plentiful, and afforded good sport to boys skilful at throwing stones.

Among mammals, I noticed scarcely anything of interest. There are plenty of wild animals, but they generally keep out of the way; the foxes and smaller quadrupeds are bolder. A little wood-chuck wanted to block the road once and not let me pass. I saw an otter trying very patiently to catch some ducks. They kept well out of his reach, but always returned when the animal swam ashore, and again scattered when he came after them. A mink was observed.

The resources of the region lie in lumbering, farming, plaster, grain mills, and saw mills; and the more speculative pursuits of limestone burning and gold mining. Last summer, work was carried on on the Serpentine, in getting out gold-bearing quartz, and about a ton was sent away for examination and analysis. Gold was also reported to have been rediscovered on the Wapskehegan, where a specimen was found many years ago.

Much plaster is used in Aroostook County, Maine, and mills have been put up there for grinding it, as it enters the United States in a crude state free of duty. It is principally brought from Albert County; for the demand for Tobique plaster has been far greater than the supply, which was limited by the number of teams able to work at hauling gypsum from the rock to the mouth of Tobique. A great many tons, however, have been taken out in this way. In 1887, the only year for which I have the returns, the amount was 1,300 tons. The railway now being built along the river, will help transport and by greatly decreasing the price of the material in the farming centres, will cause a large increase in the consumption. A considerable section of the plaster rock is in the hands of men who are largely interested in the railway, and the intention is to set up mills at the rock to crush gypsum for the New Brunswick and Canadian markets, as well as to export large quantities of raw material to the farming districts of Maine and other States.

It is also proposed to start shingle mills on the river to take advantage of railway transportation, and the large supplies of lumber still existing. Mills for grinding grain are much needed on the Tobique, as there is only one now, and it far up river. Another is being built at Red Rapids, which will be a great boon to farmers of the neighboring settlements.

Victoria County now is very much as Carleton was before the building of the New Brunswick Railway. Farming and lumbering are still carried on together, and by the same persons, and consequently neither is so flourishing as it ought to be.

A great drawback arises from the large tracts of land withheld from cultivation by the New Brunswick Railway Company, which is apparent now, when we see that almost all with that exception is being farmed, and there seems no very near prospect of this land being put on the market, though much of it is very fertile.

Within ten or fifteen years, Victoria County will probably become such another as Carleton in its farms, and have beside the advantage of the gypsum deposits and other natural resources.

ARTICLE II.

OBSERVATIONS ON THE DISTRIBUTION AND HABITS OF SOME NEW BRUNSWICK FISHES.

BY PHILIP COX, A. B., B. SC.

The sources of the Restigouche and many tributaries of the upper St. John, rise in a comparatively level area in the north-western part of New Brunswick. Thence the two waters diverge; those of the Restigouche north-easterly about one hundred and forty miles into the Bay des Chaleurs; those of the St. John, south south-easterly three hundred miles into the Bay of Fundy. Their mouths are on the same meridian, and two hundred miles apart, with an intervening coast line of about four hundred miles, two hundred and fifty of which border on the Gulf of St. Lawrence. Emptying into the latter between these rivers are several others, such as the Nepisiguit and north-west and south-west branches of the Miramichi, which have their rise in a low water-shed a little eastward of the sources referred to above.

Between these two river-systems a marked ichthyological contrast exists. In the three latter streams there is an abundance of salt water or semi-marine fish, but a dearth of the larger fluviatile and lacustrine species. Even many purely fresh water forms, frequenting small streams, and, under favourable conditions, such as the interlacing of tributaries and high freshets, spreading in time over large areas, are here limited both in numbers and species, notably the Cyprinidæ, including the carps, chubs, minnows, etc.

Though fished for years by Indians and settlers, and carefully examined of late by the writer for scientific purposes, these rivers with their numerous forest lakes have never been known to yield a single specimen of the togue or tuladi, *Salmo namaycush*, Walbaum); white-fish or gizzard-fish, (*Coregonus clupeiformis*); or fresh-water cusk (*Lota maculosa*, Le Sueur); all of which are found in large numbers in the waters of the St. John and Restigouche. In the latter rivers, too, the writer has found *Uranidea boleoides*, Girard, a small fresh-water sculpin, never before reported, as far as he knows, from the Maritime Provinces.

As a general rule, the first three are lacustrine species, frequenting the largest and deepest lakes, though the white-fish and fresh-water cusk are also fluviatile to a limited extent; yet, under the latter conditions, their preference for long, still, deep reaches, betrays their primitive habits and distribution. This is the case on the lower St. John, where their existence is probably due to a few having been originally carried over the Grand Falls from the lake region above, where they abound. Whenever thus restricted to a river life, the white-fish will, on the approach of winter, sometimes descend to the sea. To a slight extent this is the case on the lower St. John, but more characteristic of the fish in the Arctic regions, where the lower temperature of such waters must induce periodical migrations.

The togue occurs in many widely separated places in New Brunswick, such as the Chamcook Lakes, near St. Andrews; Long Lake at the Head of the Lepreaux River, St. John County, and in some drained by the Tobique. It is also found in Lake Metapedia, Quebec, whose waters empty into the Restigouche; and the writer has verified its presence in States Lake draining into the Kegewick, an affluent to the same river. After a long and careful examination of the lacustrine waters of the Miramichi, including the lake in question, there seems no room for doubt, but that M. H. Perley was mistaken in assigning this fish to the Miramichi Lake in his "Reports on the Sea and River Fisheries of New Brunswick, 1852." No trace whatever, nor other record of its occurrence there can be found.

Between the togue and fresh-water cusk there is a singular association;—the two are almost invariably found in the same lakes, but the cusk, as remarked above, is more or less fluviatile also in distribution; and, in the latter case, is held by some naturalists to return periodically to the sea. Such, however, is not a well established fact. On the lower St. John it is quite common, and the facilities for reaching salt water are excellent; yet numerous enquiries among the fishermen and fishery officers of the Bay of Fundy, and especially St. John harbor, fail to show a single specimen ever taken there in net or weir. Did the fish visit the sea, as claimed, it seems incredible that no trace of its presence would be detected in the maze of fish traps studding those waters. That it makes limited migrations on the River St. John is well known, but these are entirely restricted to a fresh water range and due to a natural preference for cool, deep reaches, modified by spawning habits. In fact, its movements are similar to those made in lakes where it lives constantly,—another presumptive proof of the lacustrine character of its ancient distribution.

The presence of the "cusk" in the Restigouche seems to have been unnoticed till Mr. Brittain and the writer discovered it there in 1888. In Lake Utopia, Charlotte County, it sometimes attains the length of four feet. It has never been reported from Nova Scotia—a fact setting strongly against the theory of an annual migration to the salt water. The "cusk" is the only fresh-water species of the Gadidæ, or cod family, und in New Brunswick.

The presence of these three forms — the togue, white-fish and "cusk"— in the deep fluviatile and lacustrine waters of the Restigouche and St. John, cannot be satisfactorily accounted for by the interlacing of their smaller tributaries. It seems more probable that their present range has been determined by causes operating in remote times in which the intermediate coast region did not participate, and by which extensive lacustrine areas were drained, leaving these species in their present widely separated localities, or obliging them to adapt themselves to the conditions of new and often unnatural habitats.

One of the best known fish of the Miramichi and St. John is the striped bass (*Roccus lineatus*, Bloch), attaining in the former river, perhaps, its greatest perfection of delicacy and flavor — an excellence doubtless due to its food, the smelt (*Osmerus mordax*, Mitchell), with which the bays and estuaries swarm. This species has a very wide distribution, ranging from the Bay of Fundy to the Gulf of St. Lawrence. Though ascending some rivers, as the St. John, far above the influence of the salt water, its fluviatile movements on the Miramichi are wholly confined to brackish water, but, unlike salmon, shad, etc., which retreat, on the approach of winter, to the deep and warmer waters of the ocean, the bass enters the mouths of rivers, and ascends to the very heads of their estuaries, where the temperature must be many degrees colder than outside. This singular habit has not been satisfactorily explained. The fishermen of the Atlantic States of America and some ichthyologists, especially DeKay, are of the opinion they hibernate, buried, or partially so, in soft muddy bottoms; and it is a strange coincidence that the Acadian French, dwelling around the mouth of the Big Tracadie, Gloucester County, N. B., hold the same views. This common belief of people so far isolated and having little intercourse, if any at all, would seem to arise from an observation of facts; yet the writer's investigations and enquiries have failed to find a well attested case in support of this theory. Others solve the problem by asserting that the bass is peculiarly insensible to cold. G. Brown Goode, of the Smithsonian Institution, is rather inclined to this view. It is not clear, however, that such is a fact; for under some conditions they are very sensitive to sudden changes, and the power of bearing a low temperature seems in proportion to size and age — the larger fish being the least affected. The latter are found at the head of the estuary where the fresh water, little affected by the ebb and flow of the tide, must fall to a low temperature; the June fry congregate in the lower part in the deeper, brackish or salt, and warmer waters; between these extremes the rest are found distributed according to size. During a thaw, when, owing to the melting snow, the temperature of the river water sinks, the larger fish are found to scatter in all directions down the estuary, to resume their former places when the freshet subsides. A low temperature destroys the characteristic voracity of the bass. In winter the stomach is invariably empty.

On the St. John it spawns in fresh, but on the Miramichi in brackish or salt water, and generally in shallow places. During the operation there is no evidence of pairing as seen among the Salmonidæ, nor indeed any definite sexual arrangement of individuals, except that the males are said to keep sometimes tidewards of the females. The eggs hatch in from thirty-six to seventy-two hours, according to the temperature of the water; and in December the fry are from two and a half to three inches long. This rate of growth is much less than on the New England coast; but in the latter case the season is longer.

The striped bass is eminently fitted to perpetuate itself. Of rapid movement; provided with formidable means of defense in the sharp, strong dorsal spines, inhabiting areas of our coast waters peculiarly free from enemies, exceedingly prolific, with the young so rapidly developed from the egg that little or no destruction of spawn can take place; this excellent food fish should be very abundant. And so it was in the Miramichi Bay until lately. In a few months of the winter of 1884 the estuary of the north-west Miramichi alone yielded 94,000 pounds, worth from twelve to fourteen cents a pound; but the catch declined, until in 1889 it was only 2,000 pounds. This falling off was due to over-fishing and the destruction of young fry in smelt bag-nets, which, with a strange disregard of consequences, were permitted to be set in their winter habitat. As this was stopped and the taking of bass prohibited for three years, these waters were soon restocked.

Respecting the distribution and number of species of Gasterosteidæ, or stickle-backs, in New Brunswick, much uncertainty has hitherto existed. Perley knew but one form —*Gasterosteus biaculeatus*, Storer; and Professor Gill, though including this and two other species in his "Fishes of the Gulf of St. Lawrence and Bay of Fundy," did not regard them as properly determined. In "Field and Forest Rambles," A. Leith Adams follows Gill without determining the doubtful forms, while J. M. Jones in his "List of Nova Scotia Fishes," see "Natural Science Institute of Nova Scotia, 1878–9," includes only *G. biaculeatus.* The writer has succeeded in establishing the existence here of three species, and has reasons for believing that a fourth also exists. A very handsome one, about three inches in length and like a diminutive mackerel in shape and coloration, is the "nine spined stickle-back," *G. pungitius,* L. Though sometimes found in brackish water, it has a decided preference for sluggish streams, ditches and ponds, resorting to springs and the mouths of brooks on the approach of winter, during which it seems as active and lively as in summer. In the latter season the writer has not identified many of these in brackish waters; but they so increase there in number on the approach of winter as to favor the idea of a seasonable migration. Notwithstanding its formidable array of spines, the nine dorsal ones diverging at irregular angles, a deviation of a highly protective character, it then falls a victim to the greedy frost fish, *Gadus tomcod,* Walbaum, which alone of all the winter fish retains the well-known family appetite unimpaired.

A second, smaller, and less beautiful form, limited to an entirely fresh-water range, is *G. inconstans,* Kirtland. As the specific name implies, the dorsal spines are variable in size and number, and arranged nearly in a direct line. They are never less than four, nor greater than six. This species has its greatest distribution in the southern parts of the province, occurring but rarely in the north.

The third form identified is *G. aculeatus,* L.—the *G biaculeatus* of Shaw and DeKay, included in Perley's list. This has been regarded as an exclusively salt-water species, and such it generally is, but the writer collected fine specimens on the Restigouche, over one hundred miles from its mouth, proving that it, too, possesses the remarkable vitality and powers of adaptation to altered conditions of life, so characteristic of the whole family. It is the largest of the sticklebacks, being fully four inches long, and has but two, rarely three, dorsal spines. These are hinged at the base and capable of being so set as to resist great pressure before yielding. The tail is keeled laterally with a sharp ridge, the function of which is not understood.

Wherever found in large numbers, these little creatures play an important part in the destruction of other species. Active, bold and greedy, they never tire hunting up spawn and fry in the shallow waters they frequent, and into which the helpless young of other species flee for safety from larger enemies.* Indeed, so marked is this spirit of destruction that they will attack and kill their own young—a singular fact, as under certain conditions, no other fish evinces more parental affection. Many not only build nests for the reception and safety of their spawn, but the males stand guard at portals, fanning the water with their fins and tails to keep up a healthy circulation, which cannot otherwise be had, as the nests are made in sluggish or altogether stagnant water. They are even said to enter the nests from time to time and stir up the eggs thus securing their more uniform aeration. These extraordinary precautions, in such strong contrast with the usual indifference of fish to the fate of their offspring, are seemingly suggested by a sense of their own destructive habits.

Their undue multiplication is chiefly prevented by certain birds, such as the blue heron (*Ardea herodias,* Linn.); American bittern (*Botaurus lentiginosus,* Motag.); green heron (*Ardea virescens,* Linn.); yellow legs (*Totanus flavipes,* Gmel.); and other waders, besides the belter kingfisher (*Ceryle alcyon,* Linn.), which incessantly prey upon them in every pond, creek, marsh and shallow lagoon. Did such a check not exist, the Gasterosteidæ would, in favored localities, cause a decrease in the supply of certain food fishes, not directly indeed, but by preying on the forms supplying the latter with food.

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* A small stickle-back, kept in an aquarium in England, devoured in five hours seventy-four young dace, which were about a quarter of an inch long and about as thick as a horse hair. Two days after it swallowed sixty-two, and would likely have eaten as many every day could they have been procured.

Of the forty genera and two hundred species of the Cyprinidæ found in North America, only six undoubted forms are known to occur in New Brunswick. There must be more, but identification of many members of this family is extremely difficult, owing to uniformity in size, coloration, and habits, as well as to changes due to season and age. Then, again, they are esteemed of no value as food-fishes — a general passport to neglect.

The shiner, or red-fin (*Minnilus cornutus*, Mitch.), is found generally distributed over the whole province, occurring in streams and brooks, and shallow portions of rivers. It is rarer in northern than in southern waters, a fact largely due to the presence in the former of great numbers of trout (*Salmo fontinalis*, Mitch.), which are extremely partial to this brightly colored and attractive minnow.

The pretty little black-nosed dace (*Rhinichthys atronasus*, Mitch),) is found in all the inland waters of the province, generally associated with the last species, but preferring smaller streams and more shallow waters. For a similar reason, it is, like the red-fin, less abundant in northern streams.

The chub, or horned dace (*Semotilus corporalis*, Mitch.), and the silver chub (*S. bullaris*, Raf.), frequent the larger brooks and still reaches of rivers; but the latter is also found in great numbers in many lakes, especially those of the Miramichi, examined by the writer in the summer of 1890. They sometimes grow to the length of eighteen inches, and weigh from three to four pounds; but never show the maxillary barbel, so characteristic of the fish in more southern waters. In the Miramichi lakes the larger ones feed principally on red-fins and fresh-water clams, with the broken shells of which their stomachs are often found gorged.

The fifth Cyprinid, heretofore reported only from the southern part of the province, is the golden shiner (*Notemigonus chrysoleucus,* Mitch.); but the writer has taken them from some lakes drained by the Miramichi. They are, as far as he knows, confined to ponds and lakes,—at least such is their distribution in New Brunswick.

The sixth species,—*Phoxinus neogæus,* Cope — the writer found in 1889. It does not seem to have been previously observed east of Michigan where it is by no means common. It is a small minnow, about three inches in length, frequenting ponds and sluggish lowland brooks, shy, quick in movement, and keeping itself generally concealed among grass and weeds.

Leuciscus argenteus of Perley's list must be dropped from the catalogue of Cyprinids. It is but the young of *Semotilus corporalis,* Mitch.

Some years ago a not uncommon fish of the St. John and north-west Miramichi was the sturgeon (*Acipenser sturio,* variety *oxyrinchus*), which found a congenial haunt and plenty of food on the muddy bottoms of those rivers. In contrast, however, with its migrations on the St. John, it never ascended beyond the influence of the tidal waters on the Miramichi, keeping well within the brackish portion of the estuary, even to the extent of spawning there. It was observed, too, that young fish varying from six to eighteen inches in length passed the winter in the estuary where they were often taken in considerable numbers in bass scoop-nets. Large specimens, however, were never so caught, from which it is inferred that on the approach of the cold season they withdraw to the deeper bay, or, more likely, ocean waters. Of late years it is rare.

It is, indeed, singular that a fish so exceedingly prolific, for a single female produces three millions of eggs, and fairly well protected by means of bony plates, should be so easily and rapidly reduced in numbers, as was the case lately on the river St. John, where by no means excessive fishing almost depleted those waters in three or four years. The drain bore no relation to the apparent fecundity of the fish. Even before that, it was by no means very common. Growing to a great size and remaining several months in the rivers and estuaries, it might be thought that the food supply would prove inadequate to the wants of large schools, and so check rapid multiplication. From evidence afforded by some stomachs examined, it does not appear that much food is consumed at this time; so that some more general and far-reaching cause must be operating to produce this effect. Being ground-feeders, and frequenting bottoms affording concealment to certain predaceous fish, it would seem that many must fall victims to those strange marine harpies—the lampreys (*Petromyzon marinus,* Linn.) Indeed the natives of the Miramichi, as well as of the St. John, account for the leaping of the sturgeon on the ground that it is trying to get rid of its tormentors. Cod-fish, too, are not unfrequently found with lampreys attached to them, and even salmon sometimes share the same fate. Squirrel-hake taken through the ice near the mouth of the Kennebecasis frequently have two or three small lampreys from six to twelve inches long clinging to a single fish. Once a lamprey has attached itself to a young sturgeon by means of the circular cupping-glass-like mouth, the latter was doomed, for it could not long survive the operation of those saw-like teeth and loss of blood. Indeed the writer has seen many sturgeons which had seemingly been killed in this way, as the circular wound on the side just behind the gill indicated. These eels are quite common in our coast waters, and ascend the rivers in large numbers.

APPENDIX.

THE REPORT OF THE COUNCIL.

The Council of the Natural History Society of New Brunswick beg leave to submit the following report for the year now ending.

MEMBERSHIP.

Additions has been made to the membership roll as follows:

Ordinary Members	8
Corresponding Members	3
Associate Members	12
Total addition to Membership	23

It is a source of gratification to the Council that the associate members have banded themselves together for the purpose of more effectively aiding in the work of the Society.

The Council desire to see a large increase in the number of ordinary members, and to this end they would ask the hearty co-operation of all the members.

It is also hoped that our corresponding members, scattered through different parts of the province, will take a greater interest than heretofore in the work of the Society.

FINANCE.

The executors of the Botsford estate paid two thousand dollars of the principal of the Botsford bequest and also paid interest for a year and a half on the bequest up to June 1st, 1892. This amount is now in the hands of the finance committee awaiting investment.

The Treasurer's report shows the following receipts and expenditures:

Balance on hand from last year	$177 34
Receipts from dues	67 00
Provincial grant	125 00
Bulletins sold	1 00
Rent from University Extension Course	22 50
	$392 84
Expenditure for year	187 75
Balance on hand	$205 09

Most of this balance will be required to pay the cost of the Bulletin just issued, and of books purchased for the library.

LECTURES AND ESSAYS.

Seven regular meetings were held, at which the following papers were read:

1892.

Feb. 2. Natural History of Fish, by Wm. M. McLean.

Mar. 1. The Stone Age in New Brunswick,— a Discussion.

Apr. 5. General Business. No paper

May 3. Address in regard to the Summer School of Science.

Nov. 1. Dr. Gesner — his Life and Works, by G. F. Matthew.

Dec. 6. Observations on the distribution and habits of some New Brunswick fishes, by Philip Cox.

1893.

Jan. 3. The Stone Age in Egypt and Babylon, by G. F. Matthew

LIBRARY.

Additions have been made to the library by the receipt of many exchanges.

In the earlier days of our Society, papers of more than usual interest were published in the "Canadian Naturalist." It has been thought desirable to have these publications in our possession, and so the first series of eight volumes of that journal has been purchased.

BOTANY.

The botanical committee report the discovery of a number of plants not heretofore known to occur in this province; also a more extended range for some plants than yet recorded. The report of this committee will be found attached. The subject of forestry is full of importance to our people, and is well worthy the attention and close study of some of our members.

MUSEUM.

Our custodian has continued his work on the museum during the year. The rooms are open every Tuesday night and every Saturday afternoon, and we invite the members to avail themselves oftener of these opportunities to examine and study the collections.

PUBLICATIONS.

During the year our tenth Bulletin has been issued and is now in the hands of the members. This number completes the second volume of this publication and is furnished with an index. Five hundred copies have been printed of all the Bulletins except No. III, of which only three hundred were printed. This proved, however, to be too few, and for some time it has been impossible to secure copies of this Bulletin. In consequence of this it was considered advisable to reprint part of it in Bulletin No. X.

FIELD MEETING.

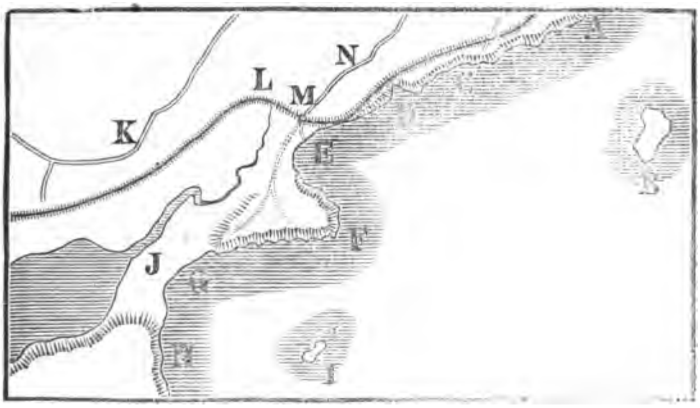
On Wednesday, August 10th, the Society held a very successful field meeting at Sand Cove and Manawagonis Beach.

The party proceeded to Sand Cove by the Shore Line R.R., and through the kindness of James Manchester, Esq., were permitted to use his grounds and buildings as headquarters for their excursion.

The geological party visited Sheldon's Point in the forenoon, and made themselves familiar with the trap-ash rocks which there form the point on the West side of Sand Cove.

From this point they walked along the Manawagonis beach, inspecting the excellent exposures of the Post-pleiocene formation shown in the clay banks and high hills of gravel along the shores. In the afternoon they visited the Fern Ledges to the eastward of Sand Cove, and studied the exposures of the Devonian sandstones and shales visible there, collecting ferns and calamites from these ancient rocks.

The zoological and botanical parties rambled around the vicinity of Sand Cove and Sheldon's Point, making collections from the woods and fields of the neighborhood. A section of this party also made an excursion to Manawagonis Island to collect seaweed and marine animals along its shores.



SAND COVE AND MANAWAGONIS.

Scale 1¼ mile to inch.

A	Negrotown Point.	H	Taylor's Island.
B	Partridge Island.	I	Manawagonis Islands.
C	Fern Ledges.	J	Manawagonis Marsh.
D	Duck Cove.	K	St. Andrew's Road.
E	Sand Cove.	L	Shore Line R. R.
F	Sheldon's Point.	M	Sand Cove Station.
G	Manawagonis Beach.	N	Sand Cove Road.

The ladies' committee had in the meantime been busy and prepared at Mr. Manchester's "pavilion" refreshments for the excursionists. Here prizes were awarded for the best collections in zoology, botany and geology, and a vote of thanks was given to Mr. Manchester for his liberality in placing his premises at our disposal.

The members of the Summer School of Science were present as our guests and a very pleasant day was spent.

A conversazione was held on August 12th. This proved a very enjoyable affair, both to the members of our Society and to the staff and students of the Summer School of Science.

By the death during the year of R. Peniston Starr, the Society has lost a valuable member. He was one of the founders of our Society and its first recording secretary. He gave liberally of his time and means to promote the welfare of the Society and always had its interests at heart.

The University Extension movement, to which reference was made in our last annual report, was continued in the earlier part of this year. Two courses were given in our rooms — one in botany, with Mr. Geo. U. Hay as lecturer; and one in geology, with Mr. Geo. F. Matthew as lecturer.

The thanks of the Society are due the press of St. John for the free insertion of preliminary notices of meetings and other courtesies.

Your Council cordially invite all the members to unite in making the coming year even more prosperous than the one just closed,

Respectfully submitted,

SAMUEL W. KAIN,
Secretary to Council.

January 17, 1893.

REPORT OF THE COMMITTEE ON BOTANY.

The following is a list of plants new to the province, or giving fresh localities for those that are described as rare in former lists. The list contains thirty-seven species of plants new to the province. These are italicized in the list that follows:

1 Clematis verticillaris, D. C. Upper Restigouche, Cox and Brittain; Douglas Road, St. John, A. C. and G. Stead; Keswick Ridge, F. G. Berton.

4a *Anemone parviflora*, Michx Restigouche River, Cox and Brittain.

6 A. cylindrica, Gray. Restigouche River, Cox and Brittain.

43a *Arabis perfoliata*, Lam. Restigouche River, Cox and Brittain.

55a *Thlaspi arvense*, L. West Side, St. John, A. C. and G. Stead; F. G. Berton.

64 Viola primulæfolia, Lily Lake, near St John. A. C. and G. Stead.

78 Polygala Senega, L. Restigouche River, Cox and Brittain; near Fredericton, F. G. Berton.

86a *Stellaria graminea*, L. Introduced from Europe. Fredericton, Brittain.

146a *Astragalus oroboides*, Hornem, *fide* Macoun. Restigouche River, Cox and Brittain; Mouth of Aroostook, Brittain.

149a *Desmodium acuminatum*, D. C. Sprague's Falls, St. Croix, Geo A. Inch; Island at Woodstock, Brittain.

157a *Lathyrus pratensis*, L. Native of Europe. Miramichi River, Cox; Salmon River Flats, below Grand Falls, Geo. A. Inch; Sandy Intervale, Big Hole, Miramichi, Cox.

228a *Epilobium Hornemanni*, Reichenb. Quatawamkedgwick River, Restigouche, Cox and Brittain.

237 Sanicula Canadensis, L. South Bay, St. John County, A. C. and G. Stead.

247a *Pimpinella saxifraga*, L. Well established for several miles along the river at Springhill, York Co. Brittain.

269a *Triosteum perfoliatum*, L. Islands in St. John River, and in Carleton County. Brittain.

279*a* *Galium boreale*, L. Restigouche River, Cox and Brittain.

307 Aster Lindleyanus, Torr. and Gr. Near Fredericton Junction. Brittain.

310*a* *A. junceus*, Ait. Below Mouth of Eel River, York County. Brittain.

310*b* *A. longifolius*, Lam.; var. *villicaulis*, Gray. Fredericton, Brittain.

330 Ambrosia artemisiæfolia, L. Gagetown, A. C. and G. Stead.

333*a* *Senecio Pseudo-arnica*, L. Small island off Grand Manan. Judge Churchill, Boston, Mass.

363*a* *Hieracium aurantiacum*, L. St. Stephen (collected by G. W. Chamberlain, Calais,) J. Vroom.

392*a* *Vaccinium Vitis-Idæa*, L. Common on and near the coast. (Omitted from list).

418 Lysimachia quadrifolia, L. Mouth of Nerepis, Hay and Brittain.

438*a* *Cynoglossum officinale*, L. Springhill, York County. Keswick, Brittain.

482*a* *Pinguicula vulgaris*, L. Restigouche River, Cox and Brittain.

493 Hedeoma pulegioides, Pers. Moss Glen, Kings Co., F. G. Berton,

503*a* *Lamium album*, L. Spreading from ballast about Newcastle, Miramichi, Cox,

526*a* *Polygonum ramosissimum*, Michx. Moncton, Brittain. *Fide*, Prof. Macoun.

576*a* Salix sericea, Marsh. *Fide* M. S. Bebb. St. John River, Brittain.

577*a* *S. candida*, Willd. Below mouth Eel River, York Co., Fredericton, Westfield. Brittain.

585*a* *S. longifolia*, Muhl. Along the St. John River. Brittain.

606 Microstylis monophyllos, Lind. Owen's Lake, St. John. G. Stead.

649*a* *Allium Canadense*, Kalm. Near Mactaquac Island, St. John River. Geo. A. Inch.

672*a* *Juncus alpinus*, Villars, var. *insignis*, Fries. Restigouche, Cox and Brittain.

715*b* *Cyperus dentatus*, Torr. and Gr. Fredericton, Brittain.

715*a* *C. aristatus*, Rottb. Fredericton, Brittain.

728*a* *Eleocharis pauciflora*, Link. Restigouche River, Cox and Brittain.

732*a* *Eriophorum cyperinum*, L. Common. Omitted from list.

740*a* *Rhynrospora glomerata*, Vahl. Near Pokiok, York Co. Brittain.

748*a* *Carex cephaloidea*, Dew. Below Bear Island, St. John River. Brittain.

763a *C. alpina*, Swartz. Upper Restigouche, Cox and Brittain.

763b C. atrata, L. Restigouche River, Cox and Brittain.

777a *Carex bicolor*, Allioni. *Fide*, Prof. Macoun. Restigouche River Cox and Brittain.

784 C. oligocarpa, Schk. The plant so reported is probably C. conoidea.

785a *C. concinna*, R. Br. Restigouche River, Cox and Brittain.

831a *Phalaris arundinacea*, L. Rather common. Omitted from list.

833a *Alopecurus pratensis*, L. Fry's Island, Hay, Brittain.

843b *Sporobolus serotinus*, Gray. Fredericton, Brittain.

843c *S. depauperatus*, Vasey. Keswick, Brittain.

843d *S. minor*, Vasey. Keswick, Brittain.

876 Puccinellia distans, Parl. (Glyceria distans of list). Near Sackville, Brittain.

855a *Agropyrum violaceum*, Hornem. (Triticum violaceum.) Restigouche River, Cox and Brittain.

894a *Equisetum palustre*, L. Fredericton, Brittain.

907a *Phegopteris calcarea*, Fée. Restigouche River, Cox and Brittain.

923a *Woodsia glabella*, R. Brown. Restigouche River, Cox and Brittain.

936 Lycopodium inundatum, L. Lord's Cove, Deer Island, 1891, Bonny River Station, St. George, 1892, J. Vroom.

940a *Selaginella spinosa*, Beauv. Restigouche River, Cox and Brtttain.

123a *Celastrus scandens*, L. (Wax-work, Staff-tree). Mactaquac Island, Islands near Woodstock, Geo. A. Inch.

DONATIONS TO THE MUSEUM.

Date.	Donor's Name and Description of Article.
1892. July	Mrs. John Berryman. — Portfolio of pressed flowers gathered in Ontario and Quebec by Mrs. Roy.
Sept.	Mrs. R. P. Starr.—A collection of minerals, mostly zeolites from Nova Scotia; also fossil plants from the coal measures of Grand Lake and the Devonian rocks of St. John; also a collection of tropical and other sea shells.
	Mrs. G. A. Hamilton.—Fossil shells and phosphate rock from the phosphate beds of Faison, N. C.; also belemnites and teeth of sharks—fossil—from Duplin, Duplin Co., N. C.

DONATIONS TO THE LIBRARY.

Date.	Donor's Name and Description of Book.
1892. Jan'y.	U. S. Geological Survey, Washington.— Tenth Annual Report, 1888–'89, Parts I and II, Bulletins 62, 65, 67, 69—'81, '82,
	Colorado Scientific Society, Denver.—Proceedings, Vol. III, Part III, and on a series of Peculiar Schists near Salida, Col., by Whitman Cross.
	Essex Institute, Salem, Mass.— Bulletin, Vol. XXIII, Nos. 7-12; Bulletin, Vol. XXIV, Nos. 1, 2, 3; "Our Trees," by John Robinson.
	Director do Museu Nacional do Rio de Janeiro.— Archivos, Vols. I (1, 2, 3 and 4) II, III, IV and V. Essay, "LeMuseum National, et Son Influence sur les Sciences Naturelles au Brasil," par. S. Netto.
	Journal of the New York Microscopical Society.— Vol. VIII, Nos. 1, 2, 3; Vol. IX, No. 1.
	The Author.—H. Forir, C. E., Liege, Belgium, Quelques particularites remarquables de la planchette de Herve. Sur un facies remarquable de l'Assise de Herve. Relations entre l'etage Landenien &c., Belge.
Feb'y.	Minnesota Academy of Natural Sciences, Minneapolis. —Proceedings, 1887–'89.
	Edward Gilpin, C. E, Halifax.—Quarterly Journal Geological Society, London, No 189.
	Nova Scotia Institute of Science, Halifax.— Vol. I, Part I (second series).
	Academy of Natural Sciences, Philadelphia.—Proceedings 1891, Part III; Part I and II of Proceedings for 1892.
	Ottawa Field Naturalists' Club, Ottawa.—Transactions, Vol. V, No. 10; Vol. VI, Nos. 1, 2, 3, 4, 5, 6, 7, 8 and 9.

DONATIONS TO THE LIBRARY — (*Continued.*)

Date.	Donor's Name and Description of Book.
1892. March.	Feuille des Jeunes Naturalistes, Paris.—Nos. 257 to 267, and Catalogue No. 15.
	Smithsonian Institution, Washington.— Annual Report for 1889; Annual Report for 1890.
April.	Life Histories of North American Birds.— Special Bulletin, No. 1.
	U. S. National Museum, Washington.—Bulletin 41 and 42.
	American Museum of Natural History, New York.—Bulletin, Vol. III, No. 2; Annual Report for 1891.
	Canadian Record of Science, Montreal.—Vol. V, Nos. 1, 2, 3 and 4.
	Marine Biological Laboratory, Boston.—Fourth Annual Report for 1891.
June.	Portland Society of Natural History, Maine.—Catalogue of Maine Plants (second edition).
	The Canadian Institute, Toronto.—Transactions, Vol. II, Part II, No. 4, Annual Archæological Report; Vol. III, Part I, "An Appeal to the Canadian Institute on the Rectification of Parliament," by Sanford Fleming.
	U. S. Fish Commission, Washington.—Bulletin, Vol. IX, 1889.
July.	Laboratory Inland Revenue Department, Ottawa.—Bulletins 1 to 30.
	Bridgeport Scientific Society, Bridgeport, Conn.—List of birds found in the vicinity of Bridgeport, by C. K. Averill, Jr.
August	Linnaean Society, New York.—Abstract of Proceedings for year ending March, 1892.
	Hamilton Association, Hamilton, Ont.— Journal and Proceedings, Vol. VIII.
	Geological Survey of Canada, Ottawa.—Catalogue of Canadian Plants, Part VI; Musci. Maps for Annual Report of 1888—1989. Contribution to Canadian Micro-Palæontology, Part IV.

DONATIONS TO THE LIBRARY — (*Continued.*)

DATE.	DONOR'S NAME AND DESCRIPTION OF BOOK.
1892. August	ROYAL SOCIETY OF CANADA, Ottawa.—Proceedings and Transactions, Vol. IX.
	GEOLOGICAL SOCIETY OF LONDON, London, G. B.—Abstracts of Proceedings, Nos. 578–594.
Oct.	THE AUTHOR.—A Chapter in Glacial History; Rivers and the Evolution of Geographic Forms; The Geology of Oneida County, by Albert P. Brigham, Colgate University, Hamilton, N. Y.
	THE AUTHOR.—My Cholera Experience, by James Death, Fairville, N. B,
Nov.	THE LITERARY AND HISTORICAL SOCIETY OF QUEBEC.—Transactions, No. 21.
Dec.	SOCIÉTÉ SCIENTIFIQUE DU CHILI, Santiago —Proceedings, Vol. II, Part I.
	NATURAL HISTORY SOCIETY OF GLASGOW, Glasgow.—Proceedings and Transactions, Vol. III, Part II.
	BOSTON SOCIETY OF NATURAL HISTORY, Boston.—Proceedings, Vol. XXV, Parts III and IV.
	NATURAL SCIENCE CLUB, St. John, N. B —Records, April 2nd, 187[illegible], to April 23rd, 1878
	COLORADO SCIENTIFIC SOCIETY, Denver —On a Series of Peculiar Schists near Salida, Col., by Whitman Cross.
	NEW YORK STATE MUSEUM, Albany.—44th Annual Report

OFFICERS AND COMMITTEES OF THE NATURAL HISTORY SOCIETY FOR 1892.

Patron — His Honor Sir S. L. Tilley.

COUNCIL FOR 1892.

President — Geo. F. Matthew, M. A., F. R. S. C,
Vice-Presidents — Geo. U. Hay, Ph. B., Wm. Murdock, C. E.
Treasurer — Alfred Seely, Esq.
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Librarian — Frank G. Berton, B. A.
Additional Members — J. Roy Campbell, Edwin Fisher and G. Ernest Fairweather.

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Geology — G. F. Matthew, G. Stead and Prof. L. W. Bailey.
Invertebrates — W. F Ganong, M. A., G. Stead.
Ornithology — Philip Cox, F. W. Daniel and A. Morrisey.
Library — S. W. Kain, G. F Matthew, F. G. Berton, Miss Grace Murphy and Miss E. Robinson.
Essays and Lectures — G. U. Hay, G. F. Matthew, G. Ernest Fairweather, Dr. H. G. Addy, J. Roy Campbell and G. Stead.
Publications — G. F.. Matthew, G U. Hay, Alfred Seely, Samuel W. Kain and G. Ernest Fairweather.
Rooms — Dr. Addy, Wm. Murdock, G F. Matthew and S. W. Kain.
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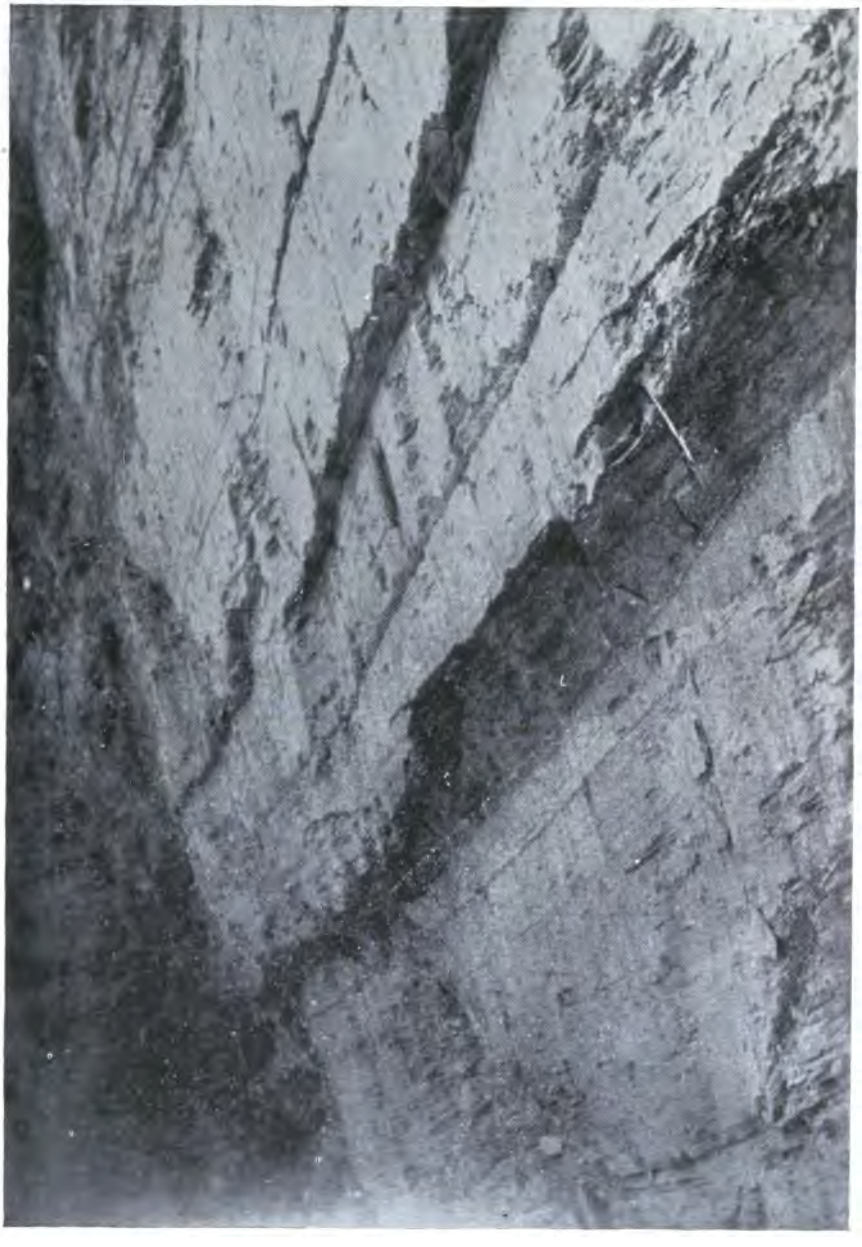

POST-GLACIAL FAULTS AT ST. JOHN.

See Page 34.

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ARTICLE I.

AN OUTLINE OF PHYTOBIOLOGY.

WITH SPECIAL REFERENCE TO THE STUDY OF ITS PROBLEMS BY LOCAL BOTANISTS AND SUGGESTIONS FOR A BIOLOGICAL SURVEY OF ACADIAN PLANTS.

BY W. F. GANONG, M. A.

Read May 1st, 1894.

FIRST PAPER.

It is clear to all botanists who note the signs of the times that the study of local Botany must take a new direction in the near future. Up to the present, under the favoring influences of intrinsic æsthetic interest, abundance everywhere of easily-handled materials, accurate terminology and excellent manuals, the systematic study of flowering plants has been the department of natural history most cultivated by those of scientific tastes, who must work without special training and away from the great centres. Hence has arisen the great class of local botanists. Their relationship to the science, however, has been one of reciprocal advantage, for not only have they derived from it an occupation of elevated pleasure, of high educational value, and of radiant good influence, but it in turn has profited greatly by their thorough explorations of local floras.

But this mutually beneficial adjustment is becoming unbalanced. Not only on the one hand are the local botanists by their very devotion exhausting their field of systematic usefulness, but as well on the other, through the consequent narrowing of opportunity for original investigation and loss of its stimulating charm, the subjective value of the science to themselves is being impaired. Discoveries of real worth and studies in pursuit of new truth can now, for the most part, be made only at the expense of journeys from home often longer than time or means justify. The question, then, is forced upon us: In what direction lies a new field for local botanists such as will yield them intellectual profit for themselves, and in which their enthusiasm, opportunities and local knowledge can be utilized for the advancement of botanical science?

Happily there need be no hesitation as to the answer. Through the studies of the younger professional botanists, particularly of Europe, there is being developed the new department, almost the new science, of Phytobiology.* It offers in the highest degree opportunities for great usefulness, and it is to be moreover the leaven of the botany of the future.

In the three provinces of Acadia we possess rich material for phytobiological study, skilled and earnest workers, and scientific societies for the correlation and communication of results. Under these favoring conditions we can enter with confidence upon the new work. And it is a fortunate coincidence, which we must not overlook, that its pursuit under the auspices of this Society will distinctly further the highest object of the Society's existence, the collection of data for a true natural history of Acadia. We have therefore a double stimulus to the careful consideration of the subject before us.

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*I am not aware that this term has hitherto been used. It seems to be our nearest possible equivalent for the generally used German "Pflanzenbiologie." and is far better than the simple word "Biology," which is now employed in several senses, or than the word "Oekologie," which many recommend, but nobody uses.

I.—THE RELATIONSHIP OF PHYTOBIOLOGY TO THE OTHER DEPARTMENTS OF BOTANICAL STUDY.

In order to thoroughly comprehend the scope of Phytobiology it is needful to examine briefly its relationship to the other departments of Botany. It will be useful also incidentally to note where to the latter the local botanist can be of service. It is of course understood that the advancement of knowledge in all departments must depend upon the specialists, who alone can command the requisite training, libraries and collections.

The vastness of the range of botanical study has made needful its division into departments. These, based mainly upon convenience, cannot be logically distinct and must merge often one into another. As they have practically segregated themselves, they are about as follows:

I. SYSTEMATIC BOTANY, the study of the relationship of plants to one another. Its ideal is to construct the real genealogical tree of plants. Based in the past chiefly upon anatomy, its future advance must be through aid of morphology, which alone affords a true guide to genetic relationship. As hitherto, the local botanist can assist by exhaustive local explorations and communication of his results to the specialists.

II. PHYTO-ANATOMY (VEGETABLE ANATOMY), the study of the actual present structure of plants and their parts, apart from causation. In its larger aspects it is rarely studied apart from Systematic Botany, but in its microscopic phases, the anatomy of cells and tissues, (HISTOLOGY) it is a distinct division of importance, studied at its best upon morphological principles. The local botanist cannot serve it.

III. PHYTO-MORPHOLOGY (VEGETABLE MORPHOLOGY), the study of genetic origin underlying adaptive form in plants. By penetrating the disguises imposed by special function, and laying bare real history it becomes the chief reliance of the modern systematic botanist, and is most closely bound up with the higher phases of Phytobiology. Its chief auxiliaries are TERATOLOGY, the study of monstrosities; EMBRYOLOGY, the study of the unfolding of the plant from its earliest germ; and COMPARATIVE ANATOMY the comparison of graduated series of structures. It is the philosophical basis, or as Darwin calls it, the soul of natural history. The local botanist can serve it by collecting and noting the conditions of monstrosities.

IV. PHYTO-PHYSIOLOGY (VEGETABLE PHYSIOLOGY), the study of the "vital" processes of the plant. It has to deal chiefly with questions of Chemistry and Physics, requires for its advancement unusually special training and cannot be served by the local botanist.

V. PHYTO-PATHOLOGY (VEGETABLE PATHOLOGY), the study of plant diseases. Of these by far the greater number are caused by parasitic Cryptogams, the practical difficulties of the study of which have caused them, together with the non-parasitic lower plants, to be grouped together for study under the department of CRYPTOGAMIC BOTANY. As it likewise includes the systematic study of these forms, local botanists can render great service by the collection and communication to the specialists of all Fungi and Algæ, with the most careful observations of the conditions of their occurrence.

VI. ECONOMIC BOTANY, the study of the relationship of plants to man's good and injury. Up to the present this department has been in the hands of practical men, has had no principles and no scientific status. Its discoveries have been far oftener the result of accident than of research, a natural corollary of the fact that the usefulness of a plant to man is usually a matter of accident and not of adaptation, some feature developed in and for its own economy happening to accord with some need or peculiarity of his. In the future it is to become an organized scientific study. The local botanists, by careful observation of effects of plants upon other organisms, may gain hints revealing new uses.

VII. BOTANICAL GEOGRAPHY, the study of the distribution of plants over the earth's surface. Upon the largest scale it deals with the great floras of the earth, the relationships of which are solvable only by aid of Palæontology and geological history. The special phase of it dealing with distribution within limited areas, belongs rather in the consideration of locomotion and competition in Phytobiology proper. To the former the local botanist can be of use by making his lists as full, accurate and discriminating as possible; to the latter he can be of the greatest service, as we shall later discover.

VIII. PHYTO-PALÆONTOLOGY (VEGETABLE PALÆONTOLOGY), the study of fossil plants. The local botanist can be of service by the collection of the fossil plants of his district, if any, and their communication to the specialists, not forgetting that there are valuable late clay, bog, and lake-bottom, as well as earlier rock-fossils.

IX. FOLK-BOTANY, the study of plants in their relationships to folk-lore, folk-uses, superstitions, traditions, history. It includes the study of all aboriginal and other unwritten lore, knowledge and names of plants. It has contributed many, and may be made to contribute more, facts of importance to Economic Botany, Ethnology, Philology, History. The local botanist can be of the greatest service by the careful collection and publication of all Indian and other local plant-lore and names.

X. PHILOSOPHICAL BOTANY, the study of origin and causation in the development of plants. Its principles, the same as those of Philosophical Zoology, we are accustomed to group together as aids to the study of "Evolution." Its advancement requires the highest possible qualities and opportunities, and the local botanist can hope only to follow, not to further it.

XI. PHYTOBIOLOGY, the study of the immediate relationship of plants to their environment. It views plants not only as living, but also as plastic beings, moulded in the past and in the present by their surroundings, and to some extent reciprocally affecting them. It has primarily to do with *adaptation*, or fitting of form and structure to function. When it traces the structural history of an adapted part, it employs morphology, which is thus inseparably connected with it; and where it considers that history causatively or dynamically, it approaches Philosophical Botany. It investigates the use or meaning of form, color, size, position, and the like in plants and their parts. It is therefore the most living and generally interesting department of Botany, and is destined to expand enormously in the future. The potential relationship to it of the local botanist has been indicated already, and will now be traced more fully.

II.—The Nature and Methods of Phytobiological Study.

Phytobiology, as we have seen, is the study of adaptations, that is of the arrangements by which plants and their parts are brought into responsive contact with external influences. It investigates in all degrees the effects upon plants of the external phenomena of the world, that is, force in all its forms and matter in its various states; and considers as well the utilization of these by plants in their organic necessities, *i. e.*, nutrition, locomotion, protection, reproduction, competition. From the most general relationships of influences and necessities, resulting in the formation of the primary organs of plants, it proceeds through all grades to the most minute analysis of details, explaining the most superficial characteristics of form, size, color, position.

The study of the reaction of the plant to the conditions of its environment would be comparatively simple were we concerned but with the present, and a completely plastic plant. But in fact all of the complexities of relationships of the past, the resultant effects of which we are accustomed to designate *heredity*, together with a little-understood *internal constitution*, of which variation is the most important phase, and which may or may not be included with heredity,—these two impose great restrictions upon the operation of the present environment. Every plant, and every part of it, represents the resultant of an enormously complex inter-operation of the influences of these three conditions—heredity, internal constitution and present environment, and each of these plants and its parts is in a state of unstable equilibrium, and readily alterable through movements in the environment. The delimitation of the effects of these influences upon plants is the ideal of Phytobiology in its most philosophical phases.

Viewed in this light, Phytobiology certainly does seem the most difficult of the departments of botany. So in its higher branches it is, but like all other branches of science, it has three grades: first, the observation of facts; secondly, the correct interpretation of the immediate meaning of these; third, the composition of knowledge thus gained into the principles of a science. It is in the first and second, but especially in the first, that the local botanist can render invaluable service. The first great need of Phytobiology, that upon which its progress depends, is accurate observation of fact in the field; for it must be remembered that it deals with living things in action and the laboratory or herbarium can help but little. Field study of how plants behave in relationship to the external world is the great aim which the local botanist should keep clearly before him.

Limiting ourselves now to the subject from the point of view of the local botanists, we have to consider first of all certain general principles.

The first pre-requisite for active work in Phytobiology is an acquaintance with what has already been learned, and some idea of the problems to be studied. The best single work upon the subject is unquestionably the admirable "Pflanzenleben,"* by Kerner von Marilaun, of course in German, as are the other very important works by Gœbel, Schimper, Warming, Stahl, Volkens, Kihlman, and others. Unfortunately there is no such work in English, and it is to supply in some measure this want for Acadian students, that a series of articles upon the subject will follow the present one.

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* While this paper is in press I learn that Kerner's work is to be translated into English under the title "Natural History of Plants.

The other great pre-requisite is a proper training in the three scientific faculties — observation, experiment, judgment.

We have already but just referred to field study, and the local botanist's opportunities for it. It cannot be emphasized too often, nor too strongly, that just here is his true field, and that his greatest triumphs will come from his observation of nature in action. It is under the extreme conditions of nature that her adaptations are best seen, and in all seasons and times and weathers the observer should be abroad, alert, persistent, sympathetic. The effects of storms on the branches, of rain on the flowers, of heat on the leaves, of birds on the fruits, of innumerable other external agencies, can be learned only by seeing them in operation, and they make clear the responsive adaptations in plants. The observer, indeed, is greatly aided by this dual nature of his problems,—the operations of agencies upon the plant, and the adaptations in the plant to the agencies; either may form a guide in the search for the other. The field observer can settle what the indoor worker can but guess at, and make discoveries of which the latter would never dream. But the more concrete treatment of this most important matter belongs under the special sections to follow.

The great adjunct of observation is apt experiment, and for Phytobiology this of the simplest and most direct sort. The mere cutting away of a branch, the isolation of a flower by a muslin cover, the pinning of a leaf to a fixed position are types of simplicity of experiment which, when tried in test of a definite question, have made clear some of the deepest principles. By what simple methods great truths can be laid bare is illustrated by Darwin's phytobiological work, particularly upon Insectivora, fertilization and seed-dissemination, and the student cannot possibly do better to prepare himself for similar work than to study these classical models. We shall have much more to say upon this subject under the special divisions to follow.

The training of the judgment, axiomatical for all good scientific work, has a particular application to our present more limited topic in connection with the nature of adaptation. As we have seen, not all the characters of a plant are adaptive. Some are simply inherited and of little or no direct use; and others are incidental to something else. The line separating inherited or genetic characters from those adaptive or immediately useful, is extremely shadowy and shifting, and the relationship of the two is of the most varied degrees. In general, the student may feel sure that the most superficial characters —form, color, size, position, etc., are immediately adaptive to readily-observable agencies, while the deeper seated characters are either adaptive to more general agencies, or are inherited and not now of vital importance. One may obtain a rough measure of the immediateness of adaptation by noting how far the given character runs throughout the relatives of that plant. If only specific, it is probably easily discoverable; but if generic, or tribal or ordinal, it becomes proportionally deep-seated and more difficult to detect. But ever there comes in also the third term of the life-equation, which is almost unknown, hence making it so difficult to solve it to the fourth. Heredity, environment, internal constitution are the three; use or reason for being is the sought-for fourth.

Again, the student is often misled by what seems to be adaptation, but in reality is not, which teaches that conclusions cannot be safely drawn from a single line of observation. Thus the presence of the sexual organs upon the *under* side of the prothallia of Ferns seems to be a distinct adaptation for placing them where the water necessary for their fertilization is most abundant. Yet experiments show that they seek not the wettest but the darkest side, and if light be thrown up upon them from below, these organs develop upon the upper surface. Indeed, very few facts can be settled from observation alone; it is always better to confirm observation by experiment. Again, one must be on the watch lest he take single individual adaptations or accidents or sports, as characteristic of the whole species. The power of individual response to certain special conditions is in some plants remarkably great, and it may accidentally or intentionally be brought about. The result may be extremely valuable for some purposes, but it is not a safe guide to the real cause of adaptation in a state of nature. Numerous observations under varying conditions in the field, with concise control-experiments—these, we repeat, are the tools of the local phytobiologist.

It remains in this connection but to point out that there are three phases of phytobiological study to be applied to every plant. There is first the investigation of the *raison d'être* of the characteristics of its individual parts; secondly, the consideration of it as a member of a biological group; and thirdly, its consideration as a member of a climatic group. The Sundew catches insects in one way, Nepenthes in another, thus showing individual adaptations; both have characteristics in common as members of the biological group Insectivora, while the former has yet other characteristics in common with its neighbors in cold northern bogs, the latter with other epiphytes in damp tropic forests. Salicornia and a Cactus have habits different enough, yet they have many characters in common as members of the biological group of succulents (water-holders), while yet, again, the former has much in common with other sea-shore plants, and the latter with other dwellers in the desert. So there are groups within groups in adaptation, and the student has to take account of generalization as well as details.

III.—THE PHYTOBIOLOGICAL STUDY OR SURVEY OF ACADIAN PLANTS.

The three Acadian provinces offer to the student of phytobiology a field of unusual attractiveness. It is true we do not possess those extremes of physical conditions which give us such extremes of adaptations as are found on deserts, high mountains, or in the damp tropics, but we have approaches to them all. The great diversity of surface of Acadia, rich forest lands and intervales, salt-marshes and sand-dunes, bare hill-tops and wind-swept cliffs, together with the richness of its flora, comprising, as it does, more than a third of all the many species found north of Tennessee and east of the Mississippi; and the great climatic changes of past times, all combine to make the plant life of Acadia of great interest, and of much promise in phytobiological results. And this is true not only of questions of individual adaptations, but the presence of all of the great biological groups, Insectivora, Succulents, Parasites, etc., with their problems, and the unusual variety of climatic groups, add to our advantages.

To proceed now to the treatment of the subject from the point of view of the Acadian student, we must first make some classification of the great subject. As elsewhere in nature none can be made which will be strictly natural and give exclusive divisions, and that to be outlined below is based largely upon convenience of treatment in this series. Under each division we shall discuss, (*a*) its most general principles, (*b*) their application to Acadian plants, (*c*) present knowledge as to Acadian plants, (*d*) problems requiring solution. We are to confine our attention in the main to flowering plants. The divisions are as follows:

A. The Adaptations of Plants to Inorganic Nature. This includes the relationship of living matter to the very physical and chemical nature of the world, and to the laws of Physics and Chemistry. It traces how, as a resultant of all these external influences, the higher plant has been produced, with its peculiar nutrition and its three primary organs, leaf, root, stem. It further considers the response in these organs to variations in the external conditions — notably meteorological conditions with varying degrees of moisture, heat, etc., and forces brought to bear upon the plant, including, with others, gravity, wind, weight of snow, beating of rain, water currents, etc., or, in a word, all the variations of the external inorganic world. Here comes the treatment of the origin of climatic groups, and of the main causes of plant-form and size, and the structural phenomena of life-cycles.

B. The Adaptations of Plants to other Organic Beings. This includes their relationship to animals, protection from them by spines, chemicals, etc., and utilization of them for defence against other animals, and of their powers of locomotion for the transfer of pollen and scattering of seed. It includes also their relationship to plants of the same and other kinds, under the former treating the little known subject of competition and development of new races, and under the latter competition upon a larger scale, with its consequent forcing of groups into parasitic, water, and other special habits originating the biological groups. It includes also symbiosis of living together of organisms for mutual advantage. In this division the whole subject of competition is most important, for the Darwinian hypothesis of evolution hinges thereupon, and very little of positive knowledge has yet been gained about it.

C. Adaptations of Plants to Reproduction. This includes the origin of the flower and its biological significance as an organ for securing the co-operation of two parents in the production of offspring. This introduces also the subject of cross-fertilization and the utilization of locomotive agencies for securing pollen transfer. Meaning of colors, shapes, time of flowering, clusters, etc., in fact, all floral phenomena belong here, together with sexual reproduction and hybridization.

D. Adaptations of Plants to Locomotion. To prevent overcrowding and to secure the advantages of development under somewhat different conditions of soil, etc., plants, like animals, must have the power of locomotion at some period of their lives. Being incapable of it directly, they have utilized the seed stage as most practicable and adapted it to be moved by the ordinary locomotive agencies of the world about them—wind, water-currents, animals, etc. The varying modes and degrees of perfection of the power thus acquired, together with the operations of man, produce important results in the distribution of plants within limited areas, and some such problems of unusual interest we have in Acadia.

E. The Biological Groups of Plants. These include the groups modified to a common special habit by influences other than those of climate, such as the Parasites, Insectivora, Water-plants. Though all of them present, they are none of them conspicuously developed in Acadia.

F. The Climatic Groups of Plants. As already mentioned Acadia does not possess extremes of climate, and hence has not extremely-adapted groups. But it has a great variety of conditions producing the following floras:

Strand,
Salt marsh,
Sand-dune,
River-bank,
Bog,
Swamp,
Fresh-water,
Salt-water,
Intervale,
Barren,
Soft-wood upland,
Hard-wood upland,
Dry sea-cliff,
Hill,
Field and open place.
Weeds.

The characteristics of these, and their common response to their common environment is a most important division of our subject. Here must be considered also the causes which allow of the persistence of northern and southern colonies within our borders.

G. A Summary of the Biological Characteristics of the Vegetation of Acadia, correlating our previous studies, and bringing them into touch with other departments of Botany, principally Botanical Geography and Botanical Philosophy. Here we must consider recent changes in the flora, and the causes of the introduction of northern and southern colonies, and finally the general phytobiological status of the Acadian flora.

So much for a general view of our subject. We have now to enter upon the special treatment of its divisions, one of which I hope to present each year to this Society. I have every confidence that Acadian Botanists and Phytobiology will prove reciprocally adaptive.

The University, Munich, Germany, March, 1894.

ARTICLE II.

THE CRYSTALLINE ROCKS NEAR ST. JOHN, N. B., CANADA.

By William D. Matthew, Fellow in Geology, Columbia College, N. Y.

(Read May, 1894.)

Among the many attractions which St. John offers to an intelligent visitor, the variety and interest of the rocks in and around it, is by no means the least. Few places, if any, afford a greater number of geological formations within so limited an area, and the scanty soil, which is the despair of the farmer, is hailed with delight by the student of lithology. Yet, on account of its distance from the great centres of learning in the United States and in Canada, the details of its geology have been worked out chiefly by local students, and their excellent work is perhaps not as well known elsewhere, as it otherwise would be. The complicated structure of the neighborhood has made it impossible to get satisfactory results without the most careful and accurate study, and this cannot so well be made in the less settled districts at a distance from the city. But it may, I think, be safely said that southern New Brunswick has been as carefully surveyed as is practicable until it becomes more thickly settled, and hence more accessible.

In the present paper I do not propose to deal much with the structural geology of the country, but rather to discuss to some extent the character of the various rocks around the city, and especially the igneous ones. The facilities for the study of these have in late years been greatly increased by the use of thin sections of the rock, which can be examined under a polarizing microscope; thus bringing to light many interesting structures, imperfectly, or not at all seen in the opaque specimen.

The pioneer geologist in New Brunswick was Dr. Abraham Gesner, who conducted between 1839 and 1843, under the Provincial Government, a geological survey, which published a number of reports on the geology of the province, dealing chiefly with its economic aspects, the prospects for mining and agriculture. After the union of the provinces, a second and more thorough survey was made under the Dominion Government, and the results of this survey in southern New Brunswick were published in the Report of 1871, and later ones. The structural geology of this paper is mostly summarized from these reports. The field-work for this part of the province was done by Dr. L. W. Bailey and Dr. G. F. Matthew, President of this Society, joined later by Dr. R. W. Ells. The map accompanying this paper will more fully show the geology of the vicinity of St. John, being on a larger scale than that published by the Canadian Geological Survey.

Saint John is built on the upturned edges of grey Cambrian slates, which underlie most of the peninsula forming the city proper, and the "Valley" to the north of it. At the end of the peninsula is a small remnant of very similar slates of Devonian age, separated from the Cambrian by a band of older trap rock. The face of the hill back of the Valley is composed of hard and fine-grained flinty felsites, very much cracked up and jointed; and behind these lie limestones, quartzites and gneisses, forming a rough, broken country which extends to Kennebecasis Bay. Across this broken country stretch a number of bands of solid and massive granite rock, in ridges and hills covered by a thin growth of stunted firs and spruces, or often turned into desolate barrens by repeated forest fires. Northwestward towards Boar's Head is a small area covered by coarse red conglomerate and sandstone, of Carboniferous age.

All these formations have a general strike approximating north-east and south-west. Following them south-west, at the mouth of the harbor, we find the Devonian slates continuing along the "Bay Shore," where the well-known "Fern Ledges" have afforded beautiful specimens of ferns and insect wings. On this side of the harbor the igneous rock is found to increase in width, forms most of Carleton Heights, and appears in several hills along the shore. The Cambrian slates of the city cross to Carleton, but are cut out beyond the Falls by a faulting which has caused the felsites and limestones to the north to encroach on them, and to the south-west of the Falls everything is buried under ridges of glacial drift. The limestones and gneisses continue across the river and extend to the west and south-west for a long distance. One of the bands of granite crosses over from Indiantown to Pleasant Point, and makes a high, round-topped ridge on the west side of the river along the the Narrows. Other masses of granite appear beyond, but have been less carefully studied.

The succession of the stratified rocks in point of age is as follows:

1. **Limestones, quartzites and gneiss.**
2. **Felsites and trap.**
3. **Cambrian slates.**
4. **Devonian slate and sandstone.**
5. **Carboniferous conglomerate and sandstone.**

Overlying all these are deposits which have not yet been consolidated into rock. These are:

6. Glacial debris, or "drift," covered in places by gravels.
7. Marine clays, or "Leda-clay," formed when the land was lower than at present.
8. Marine sands, "Saxicava sand," formed in a shallow sea.
9. River alluvium and salt marsh, (the land at or near its present level, and) the deposit still forming.

It is only with the first two members of the series of stratified rocks that I propose to deal at present. The later rocks, showing clearly their original character of sand and mud, and yielding unquestionable evidence of their age in the form of fossils, are of interest chiefly to the palæontologist. But the pre-Cambrian rocks contain practically no direct evidences of life, and are, besides, so much changed that it is often difficult to tell what they originally were.

THE METAMORPHISM OF ROCKS.

One is apt to think of a rock as something fixed and unchangeable — and so indeed it is, if we measure by our own short span of life. But in the time-scale of the geologist, rocks, like living forms, are seen to change with changing conditions.

To go back to the beginning, the first crust of the earth must have solidified from a molten mass, or "magma," as it is called, much like the lavas of modern volcanoes. Whether this crust formed over a liquid interior, or one mostly solid, is a matter of conjecture, though the weight of evidence tends to show that now, at all events, the earth is solid throughout, and molten areas, if they exist, are only of local extent. The rock of the original crust would be composed of minerals formed at a red or almost white heat. As it cooled down, these minerals become *unstable*, that is, they tend to change chemically into other combinations, and this change is greatly assisted by exposure to air and rain. Part of their substance is dissolved away, the rest left as loose grains, or changed to new minerals, which are usually softer than the original ones, and are not in large and solid crystals, but in a fine, loose powder, or mud, so that they are easily washed away by the water and carried down by streams to the sea, where they are deposited as sediment. This chemical change, or weathering, is one to which all rocks are subject, and it is the great agent by which they are worn away, the grinding and battering action along sea-coasts playing but a subordinate part.

If the sediments are deposited in a place where the earth's crust is slowly sinking, more and more material is piled up on top of them, weighing them down with an enormous pressure, and they gradually settle into a campact mass. The water contained in this mud is under a very heavy pressure as well, and as the mass sinks deeper it comes more and more within the influence of the earth's internal heat. By this combination of heat and pressure the solvent power of water becomes much greater, and it dissolves out a considerable part of the rock. As the mud settles downward and becomes more compact, it is evident that the water will work its way upward, so that throughout the mass there will be relatively a continual, slow, upward seeping of water, charged with all the dissolved rock it can carry. This water will come into zones of less heat and pressure as it rises, and must then deposit some of its mineral matter, cementing the compacted sediment into a solid rock.

As the sinking continues, the heat and pressure increase, and the remaining water has a more powerful influence, enlarging the old crystal grains and changing the surface-formed minerals into new ones, which are much more crystalline and harder. Finally the rock passes into a state in which it is only kept from melting by the enormous pressure from above, which, by preventing the slight expansion which rocks undergo in becoming fluid, compels it to remain solid.

THE ORIGIN OF IGNEOUS ROCKS.

If now this pressure be relieved, as it would be if a crack should form at the surface and extend down into the buried rock, the whole mass liquifies and squeezes up through the crack, pushing apart the walls as much as it can, part of it perhaps reaching the surface and pouring out over it, part solidifying on its way up. This molten magma contains the one or two per cent of water that still remained in the sediment after it had progressed far down into the region of internal heat; and this water greatly assists in keeping it fluid.

The part that reaches the surface cools quickly, and much of its contained water escapes as steam, being now released from the pressure that had kept it liquid. This steam blows up the lava into scoria and pumice, or shatters it into fragments, which are thrown from the mouth of the crater by the ascending steam, and scattered far and wide over the country round. The coarse fragments will fall near the opening, making a volcanic breccia, so called; the finer material will travel further and form beds of volcanic ashes or tuff. Some may fall into the sea — all indeed, if the volcano be sub-marine,—

and will then be worked over by waves and currents like ordinary sediments. The solid lavas will have cooled at their surface, too quickly for crystals to form, and will be glassy rocks or obsidians. Away from the surface, if the lava stream be thick enough, crystals will have had time to form, and the rock will be full of small crystals.

The part of the magma which failed to reach the surface will cool very slowly, so that its crystals will be comparatively large. They will finally interfere with each other's growth, and their boundaries will not be smooth faces, but irregular surfaces, the rock being made up of more or less roundish grains of different minerals. This structure is called *granitic*, as being best shown in the granites. But suppose the rock is interrupted while it is cooling, when some large crystals have formed, but before they have begun to interfere with each other; and pushing up to the surface, cools there. The still liquid part will solidify as a mass of minute crystals, or a glass, and through this will be scattered large ones. It has then a *porphyritic* structure, an extremely common one in volcanic rocks.

It is evident that a large mass of molten matter cooling slowly at a considerable depth will have great influence on the surrounding rocks, not by its heat alone, but especially on account of the highly heated water it contains. As it crystallizes, much of this water will escape, and, intensely heated and loaded with dissolved material, will work out into the surrounding beds, producing new minerals and re-crystallizing old ones. These contact effects will be most conspicuous next the granitic rock, and will gradually decrease as we go away from it.

EROSION AND FOLDING.

Let us now suppose that in the area we are discussing the slow sinking of the crust stops, and a slow elevation begins. The sediments last deposited will be raised out of water, eroded by air and rain, and carried off by the streams to some other region. As the elevation and erosion continue, strata will be exposed at the surface, which are more and more altered. In the course of time the rocks overlying our granitic intrusion will be all swept away, and we will have the granite (with a zone of altered rocks around it) brought to the surface. As time went on, yet more of the surface rock would be carried off, till finally we would have brought to light the most highly altered rocks, scarcely distinguishable from the granite itself. As all these rocks successively come to the surface their minerals are altered and destroyed by air and rain, and the new minerals formed, with the remnants of the old, are swept away, carried off and deposited as sediments in some other area, there to undergo the same cycle of change that has been already outlined.

From causes which as yet are not well understood, the upper crust of the earth has been folded and wrinkled — like the skin of a dried apple, to use an old comparison. The immediate cause of this folding seems to be a side thrust or pressure coming from that part of the crust which underlies the great oceanic areas. The crests of the folds are first exposed above water and are rapidly eroded; the hollows are slowly worn away, or, if under water, are filled up by later sediments, which in their turn are folded and squeezed together by the ocean thrust. The strata are thus exposed more or less on edge, instead of flat-lying; and this up-tilting is most marked in general, in the earliest rocks, where the action has been going on the longest.

COMPOSITION OF IGNEOUS ROCKS.

Since an igneous rock is a mixture of minerals, we do not expect to find a definite or unchanging composition in any one variety. The minerals present depend on the chemical composition of the molten magma from which it cooled ; and within certain limits this composition may have varied indefinitely. But this variation is governed by certain rules.

All igneous rocks contain a large proportion — from thirty to seventy-five per cent — of silica. But those especially rich in silica contain the largest amount of potash and soda, and very little lime, magnesia, or iron ; on the other hand, those poor in silica contain a large amount of lime, magnesia and iron, almost no potash, and not much soda. The former are called *acid*, the latter *basic* rocks. Alumina is present in considerable amount, averaging ten to fifteen per cent, in all rocks except the extremely basic ones, in which it is sometimes almost wanting.

Corresponding with the chemical change is a change in minerals. The common minerals in igneous rocks are almost all silica compounds. We have first *quartz*, which is pure silica. Then the *feldspars*, which are silicates of alumina with some other basic oxides. *Orthoclase* feldspar contains potash and a little soda. *Plagioclase* feldspar contains soda and lime in varying proportions. These are the chief light-colored minerals. The dark minerals are *mica*, *hornblende*, *augite*, *hypersthene* and *olivine*. *Mica* is a complex silicate, containing alumina, potash, magnesia and iron. There are two species; one, *muscovite*, is a potash-alumina silicate, and the other, *biotite*, is a magnesia-iron alumina silicate. The first is rarely seen in igneous rocks, except a few very light colored granites. The second, which is much darker in color, is a common constituent of them. *Hornblende* and *augite* are silicates of alumina, lime, and magnesia and iron. *Hypersthene* and *olivine* are magnesia-iron silicates. Orthoclase feldspar, and some varieties of plagioclase, contain a very large proportion of silica, while hypersthene and olivine contain less than the rest. All these minerals are of definite composition, but one basic oxide may replace another to a certain extent. *Magnetite*, an oxide of iron, is found in noticeable amount in the more basic rocks.

We name the rocks according to the minerals most abundant in them, and also according to their structure, which is granitic in those which have cooled at a considerable depth, porphyritic, or glassy, in surface-cooled masses. Among the granitic rocks we have a series from acid to basic, as follows: *Granite*, composed of quartz, orthoclase, and usually some plagiolase, and a small amount of mica, or hornblende, or both. This grades into *Quartz-diorite*, composed of quartz, plagioclase, and often some orthoclase, and with rather more hornblende, or mica. By the quartz decreasing and hornblende increasing, we get a plagioclase-hornblende combination, or *diorite.* This, again, by augite replacing the hornblende, becomes a *gabbro*, and the gabbro, with incoming of hypersthene and olivine, becomes an *olivine-gabbro.* This, finally, by decrease of the feldspar, grades into a *peridotite*, composed of olivine with hypersthene, or augite, or both.

Corresponding to these intrusive rocks we have different volcanic rocks, which are not so easy to distinguish, as the minerals are not well crystallized. The porphyries and felsites correspond roughly to the most acid intrusives, the porphyrites to the intermediate ones, and diabase to the more basic.

SEGREGATION.

A curious, and for a long time unexplained fact about volcanic rocks is that lavas erupted from the same centre often differ markedly in composition, some being more basic, some more acid. Correspondingly, we find with intrusive rocks that one part of the intrusion often differs much from other parts. This variation follows closely the rule already noted, that the potash and soda go mostly with a high silica percentage, the lime, iron and magnesia with a low one. Hence, it can scarcely be due to accidental differences in the original melted mass, and it is believed that the cause lies in a tendency in all molten magmas to split gradually into acid and basic divisions, the potash and soda having a greater chemical affinity for the silica than have lime, iron, or magnesia.

THE ROCKS ABOUT ST. JOHN.

There are around St. John almost all of the different kinds of rocks whose origin we have discussed, and some are of considerable interest.

Metamorphic Rocks.— To begin with the oldest, we have the "Laurentian" series, of limestones, gneisses and quartzites.* These are very highly altered rocks, but were once sediments probably very like those of the present day. The quartzite was once a sand, composed of loose rounded grains of quartz, but now all the spaces between the grains are filled up with quartz similar to the grains themselves, so that they cannot be distinguished except by examining a thin section with the microscope. The limestone, probably once fine grained, or made up of small fragments of the skeletons of low organisms, is now crystalline, and shows (with a few exceptions) no traces of its former condition. The gneiss was probably once a sandy shale, but all of its original mineral grains have disappeared, and we have in place of them a rock composed of far larger grains of quartz, feldspar, mica and hornblende, as densely packed as in a granite. The original bedding of the rock is still quite plain, however, as the sandier layers have been converted in a more quartzose rock, and the more clayey ones into micaceous bands. In Quebec and northern Ontario are vast areas of gneissic rocks which are much more metamorphosed even, than those around St. John, and are extremely massive and coarsely crystalline. They are everywhere cut through by granite intrusions, and it is thought doubtful whether they ever were ordinary sediments of the modern type. But there can be little doubt about the original nature of the gneisses near this city.

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* The reader may observe the areas occupied by these and the following divisions of the rocks at St. John, by referring to the accompanying map.

Granite — Cutting through the Laurentian rocks north of the city there are several granite intrusions. The granite is fairly coarse-grained, showing that it solidified at a considerable depth; but it contains large porphyritic crystals of orthoclase feldspar, which must have formed at a still greater depth. In the mass of the rock there is more plagioclase than orthoclase, hence it is not properly a granite, but rather a quartz-diorite, except in a few places where the orthoclase predominates. The different areas of the rock differ considerably in appearance, the wider ones being more coarsely crystalline, and with more of the porphyritic crystals. But as all have in common a number of peculiarities, they were probably injected from the same molten magma, and approximately at the same time, the variation being due to segregation. The dark minerals in the granite are biotite and hornblende in about equal amounts in the fresh parts of the rock. But the biotite is an unstable mineral when near the surface, and tends to alter to hornblende, or epidote, so that we often find these minerals replacing it and still retaining the outward form of their original. These, in turn, when at the surface, are acted on by rain and changed to soft green aggregates of chlorite, calcite, etc. Scattered in small quantity through the rock are minute crystals of the rare zircon, which can be separated by crushing and "panning out," and show under the microscope very perfect crystal forms.

The contact between the granite and surrounding rocks is usually hidden. Near King's mill, Fairville, it is exposed by a small quarry in the limestone, and here the lime is whiter and more crystalline near the granite, and close to it contains great numbers of garnet crystals. Besides these evidences of contact-metamorphism, there is between the lime and the granite a narrow band of a peculiar rock like a "vein-granite," which was probably deposited by the heated water around the edge of the intrusion. Further east, near Pleasant Point, the river has left some remnants of the surrounding rock clinging to the side of the granite cliff; and here, too, the limestone and gneiss are coarser than usual, and garnet is developed, sometimes forming entire layers of the rock.

Gabbro.— Another type of intrusive rock appears in two little knobs at Indiantown, and in a larger one making the hill just north of Dolin's Lake, back of Rothesay.

This is a basic rock, very coarse grained, black and heavy. It is composed of plagioclase feldspar, hypersthene, olivine and augite in variable quantities, and is therefore to be called an *olivine-gabbro.* The last three minerals, all unstable ones, have been changed more or less to hornblende. By taking different specimens, all stages of this change can been seen, some parts being almost fresh, others completely changed to a hornblende-plagioclase rock, which for the sake of distinguishing it from an igneous rock, *originally* composed of these minerals, is called an epi-diorite, or gabbro-diorite. The olivine and hypersthene were not of the right chemical composition to change to hornblende, had they been alone. But wherever they came in contact with the feldspar, the necessary alumina and lime was supplied, and a hornblende crust or rim formed between the two, and enlarged itself at the expense of both minerals. In thin sections this gives a very pretty effect; the pale brown olivine is surrounded by a rim of bright green needle-like crystals of hornblende, radiating out into the colorless feldspar.

The little area at Indiantown, close to the end of Main street, and south along the water-front, furnishes a very good example of segregation. At its south end it is composed chiefly of feldspar, with very little of the dark colored silicates, and is a greyish white rock, with dark spots. As we go toward the north end, the dark silicates increase in amount and the feldspar decreases, till finally the rock is made up almost entirely of olivine, hypersthene and augite, and is of a dense and glistening brownish black color.

The Volcanic Rocks.— Between the Laurentian limestones and the Cambrian slates lies a rather narrow band of felsite of intermediate age. Its original nature is rather doubtful, but it has been considered to be most probably a consolidated volcanic ash. The series to which it belongs is greatly developed to the north-east, in the Quaco hills, and there is made up of ancient lavas, volcanic breccias and ashes. The lavas are usually more or less porphyritic, and some show, when sectioned, indications of having once been partly made up of glassy matter.

It seems that in pre-Cambrian times southern New Brunswick was part of a great volcanic region, which extended down to the south-west at least as far as the Carolinas. From the St. John volcanoes were thrown out great quantities of lava and ashes, some on land, some under water. The centres of eruption appear to have been some miles to the east of the city, so that only the finer ashes reached this far west, and formed the fine felsite band.

The parts of the lava flows next the surface would cool suddenly and be glassy. Those farther from the surface would be fine-grained, with usually some porphyritic crystals, which had formed in the depths of the earth from which the molten rock had come. Along with the solid lavas vast quantities of pumice, broken fragments of rock and fine ashes were cast up, the finer ash drifting some distance with the wind.

In the course of time these volcanoes became extinct, were partly worn away, partly covered up by the sinking of the land, and later sediments deposited on them. The ashes and breccias were consolidated into a hard rock, metamorphosed so as to be almost unrecognizable; the harder lavas suffered less change, but their glass was converted into a felsitic mass, made up of exceedingly minute crystalline grains of different minerals. Then, through later folding and erosion, these altered rocks were once more brought to the surface, as we see them now.

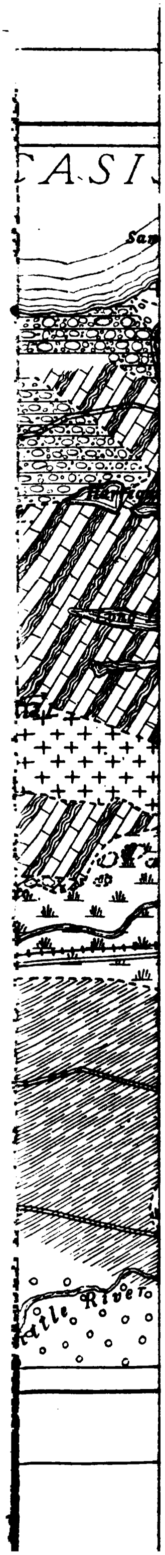
Characteristic Structures of Volcanic Rocks. — In modern glassy lavas we usually see imperfect forms of crystallization, one common type of which is composed of a quantity of minute needles of crystalline quartz and feldspar, radiating out from a centre and forming a little ball, called a *spherulite.* These spherulites are still preserved in some of our ancient lavas, and give one proof of their original character. Again, in modern lavas, or slags, we often see a series of wavy parallel lines, produced by the flowing of one part of the viscous fluid over another. These "flow-lines" are often to be seen in some of the old New Brunswick lavas. In the upper part of a lava flow, the contained water, relieved from pressure, bursts into steam and fills the lava with little cavities, or vesicles. So, too, in parts of these old volcanic flows we find vesicles abundant; but they have subsequently been filled in with quartz and calcite by the mineral-bearing solutions which contrive to seep into the rock during its metamorphism. Such are some of the proofs of the volcanic origin of these rocks.

The breccias are seen to be made up of angular fragments of rock of all sizes and lying "every which way." The whole mass at the same time is flinty, and breaks in the same way as the felsites. In thin sections we can see that it is made up entirely of pieces of lava, large and small, which often show some of the characteristic structures of which I have spoken.

Some of these rocks have been so much metamorphosed that they have taken on a schistose structure, and almost nothing is left of their original character, which can only be assumed from their association and the finding of intermediate stages of alteration.

Basic Volcanic Rocks.—A more basic type of volcanic rocks is to be seen in a series of knobs along the southern side of the Cambrian slates. The heights on which the Martello tower is built are of this material, and to the east of the city it crops out on the shore south of the alms-house, and again back of the penitentiary. This rock is a plagioclase-augite mixture, or diabase — one of the rocks commonly called "trap." It is often very full of vesicles, which are filled in with white quartz. At the shore, by the alms-house, it outcrops as a heavy dyke in green and red slates, instead of a surface flow; in all probability part of the fissure is exposed, through which the magma found its way to the surface. It is interesting to note that as far back as 1840 Dr. Gesner pronounced this to be a dyke, though he was not able to find its edges, and supposed it to graduate into the surrounding slates. By a careful examination, however, the edges may be traced on both sides; but with some difficulty, because the igneous rock has baked the slate near by into a hard flinty mass, very like itself.

Dykes.— Great numbers of small dykes are to be found cutting across all the older rocks near St. John. Most of them, probably, were formed about the same time as the great volcanic surface flows, which they closely resemble, though wanting the special characters which have been mentioned as distinguishing surface flows. Almost all are diabase, dense, sometimes porphyritic, more generally fine grained. A very few porphyry and porphyrite dykes are also known.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SUMMARY.

To sum up, finally, we have represented at St. John, besides the ordinary sedimentary strata, the following types of rock:

1. A varied series of metamorphic or crystalline stratified rocks.
2. Intrusive rocks, both acid and basic, showing well the phenomena of contact-metamorphism and segregation.
3. A great and varied series of volcanic rocks — lavas, breccias and ashes — all of pre-Cambrian age.
4. Dykes, mostly trap (diabase) and with some exceptions also of pre-Cambrian age.

EXPLANATION OF THE MAP.

I am indebted to the courtesy of the New York Academy of Science for permission to use the plate for this map, which first appeared in connection with my article, read before that body, on April 16th, 1894.

The reference column in the margin will sufficiently show the meaning of the various markings used in the body of the map. No attempt has been made to distinguish the bands of limestone in the Laurentian rocks, as this would necessitate a more detailed survey of the district than it has been possible to make. Areas where the limestones have been found are not specially distinguished here, but are designated in a general way on the map of the Canadian Geological Survey.

ARTICLE III.

MOVEMENTS OF THE EARTH'S CRUST AT ST. JOHN, N. B., IN POST-GLACIAL TIMES.

By G. F. Matthew, D. Sc., F. R. S. C.

Read 6th November, 1894.

A year ago, when passing through City Road, St. John, in an electric car, the writer caught sight of a sloping ledge of slate, which appeared to show evidences of faulting. On re-visiting the spot afterward he found that the appearance was not illusory, but that there had been uplifts of these slates along old fault lines since Glacial times.

An examination of the rock surfaces at other points showed that this was not a solitary instance of displacement, but all along this hillside—for a distance of half a mile—great numbers of these faults could be seen. Though the individual displacements were generally slight, yet owing to the great numbers that exist the change of level is very considerable, and the importance of these faults is greater that at first sight would appear.

Their influence on the structural geology of this district seemed of sufficient importance to make a more careful examination desirable, and the writer accordingly undertook a rough measurement of the faults at the more important exposures.

At City Road, just under the City Hospital hill, are some ledges on the south side of the street which project above the street level, the street having been partly excavated from the solid rock at this point. These ledges have a thin covering of soil, but in some places the covering has been removed, and the smooth, glaciated surface of the slates is visible.* (See plate).

The glacial striæ here have a course south, five degrees east, which is more than the usual easting, because the crest of the Hospital ridge slopes downward to the north-east near here. The slates are full of fault planes, running in several directions. The prevailing ones are parallel to the hillside and have a course north, sixty degrees east. It is along this line of fault planes that the principal displacements have occurred. Movement has also occurred along a set of planes having approximately a south-west (south, thirty-five degrees west) course.

The rough measurement of the spaces between the faults, and the amount of displacement, gave the following results, beginning at the City Road:

Estimated Distance.		Displacement at the Fault.
Feet.	Inches.	Inches.
0	6	¼
1	0	¼ to ½
1	0	2
1	6	4
1	6	1 to 2
1	0	¼ to ½
1	4	¼
0	9	¼
3	0	¼
11	7	10

In the half nearest the road, toward the western end of this exposure, there is a diagonal fault, course south, thirty-five degrees west, of about one inch, having a hade of seventy degrees to the south-east, and having the downthrow on the north side.

Other measurements were taken at Rock Street. Back of Fowler's mill on this street, there are quite distinct faults, some with a throw of three to five inches.

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*I am indebted to Mr. Gilbert Van Ingen of Columbia College, New York, for the photographic view from which the accompanying plate has been made; it shows the faults described in the first of the tables given above.

Further along the street, eastward, but off it to the south, there is a space about two hundred and forty feet from north to south, going up the hill where the slates are well exposed. For about one hundred and fifty feet of this space the glacial striæ and faults are well shown; beyond this, higher up the hill, the rocks are too much weathered to give trustworthy results.

The striæ at this locality have a course of south, five degrees west, and the fault planes along which the principal displacements have occurred, have, as at the City Road locality, a course of north, sixty degrees east.

The following faults were observed here, beginning at the north side of the exposed ledges:

	Feet.	Inches.		Inches.		Feet.	Inches.		Inches.
Distance,	4	0	Displacement.	2½	Distance,	1	0	Displacement,	½
"	1	0	"	2¼	"	5	0	"	½
"	2	6	"	3½	"	0	8	"	1
"	0	5	"	1½	"	1	2	"	½
"	4	2	"	4¼	"	2	0	"	½
Surface of the rock concealed.					"	3	0	"	½
Distance,	2	0	Displacement,	1	"	1	3	"	1
"	1	2	"	1¾	"	0	4	"	¾
"	0	1	"	1	"	4	0	broken surface.	
"	0	9	"	1¼	"	1	0	Displacement	1¾
"	1	2	"	0¾	"	2	6	"	½
"	0	10	"	1	"	2	6	"	5
"	1	4	"	1	"	1	4	"	½
"	1	2	"	1	"	3	0	"	3
"	0	2	"	½	"	2	6	"	1
"	1	2	"	2	"	2	0	"	1
"	0	10	"	½	"	0	6	"	¼
"	0	10	"	½	"	0	2	"	¼
"	0	10	"	1	"	0	1	"	¼
"	1	8	"	1¾	"	2	0	"	¼
"	3	6	"	1¼	"	0	4	"	¼
"	2	6	"	1	"	0	8	"	1
"	1	2	"	½	"	2	0	"	1
"	3	0	"	½	"	3	0	"	½
"	1	3	"	1½	"	0	2	"	½
"	0	10	"	½	"	2	0	"	½
"	2	6	"	½	"	2	0	"	¼
"	0	2	"	1¼	"	7	0	"	1
"	0	10	"	1	"	9	0	"	2
"	1	4	"	¾	"	4	0	"	1
"	1	3	"	1½	"	2	0	"	½*
"	1	2	"	2	"	15	0	broken surface.	
						156			68 in.

* Down-throw on south side, all other down-throws on north.

In this space of one hundred and fifty-six feet, with sixty faults, all the down-throws were on the north side, with one exception, marked with an asterisk, where the down-throw is on the south side.

For spaces of forty feet, four feet and fifteen feet, respectively, in and beyond this space, the ledges were either covered by soil, or so worn and broken that the faults could not be traced. There were diagonal faults at this Rock street exposure, but not being well shown, they were not measured.

Further along this hillside, at the east end of Charles street, there are other ledges exposed. Here the striæ run south, fifteen degrees west. The principal set of fault planes has a course of north, sixty degrees east, and a steep hade south-west. The down-throw, as at the two former places, is at the north side of the fault. The diagonal faults are well shown here; one set has a course from east to west and a hade of about fifty degrees to the south; along these fault lines the down-throw is on the north side.

From Charles street westward to Sewell there are no good exposures, partly owing to the land being covered by buildings, and partly to the fact that there has been considerable filling in at Garden and Dorchester streets.

Proceeding toward the west end of the "Valley" the slate ledges are again exposed along the hillside south of Sewell street, at the north end of Peel street. This is at the junction of the fine black shales of the Bretonian division of the St. John Group with those coarser, lighter coloured slates of the Johannian division. The exposures are of small extent, but there are several of them. The glacial striæ here run south, twenty-five degrees west, and the fault planes along which the uplifts occur have the usual course. East of the end of Peel street, in a width of eight feet, four faults were noticed, varying in throw from one-quarter of an inch to one inch. The down-throw was on the north side. West of the end of Peel Street are several small exposures. At one the fine, dark slates are exposed for a breadth of fifteen feet. Here are twelve faults, varying from half an inch to one inch, and one fault with a throw of five inches. All have the down-throw on the north side. The striæ here have a course south, twenty-five degrees west. Further along the hillside, opposite Pond street, there are several faults with down-throws to the north. These are in black slate, and so worn by the weather that they could not well be measured. Here the striæ have a course south, thirty degrees west, a greater westing than at the other localities named above, because the ridge bounding the valley to the south here begins to descend westward toward the sea level.

A few observations outside the city limits have been made, which show the presence of these post-glacial faults at other points. Thus, at the north-east corner of the Church of England burying-ground, at the eastern border of the city, there is a glaciated ledge exposed, showing two slight post-glacial faults, of one-quarter of an inch each, having the down-throw on the south side. At the head of Courtenay Bay, on the eastern side, the ledges at the shore, and near by on the highway, show several post-glacial faults, with down-throws on the north side.

The excellent preservation of the pre-glacial faults in the "Valley" at St. John is due to various causes. In the first place the rock along the hillside consists of the fine shales of the Bretonian division of the St. John Group, which are well adapted to receive the finest striæ, and they are on the "stoss" side of the hill, and so are very distinctly grooved. Owing to their sheltered position behind this hill the surf did not reach them, when the country was submerged after the glacial period; and being non-calcareous, they were not affected by percolating surface water when the country was again elevated above the sea.

It will be noticed that the down-throws along the lines of fault are almost universally on the north side of the fault planes, which in the case of these planes is also the under side, for the hade of these faults varies from vertical to seventy degrees inclination to the south-east. We may suppose, then, that the appearance of these faults is due either to a failure of support beneath, *i. e.*, a weakening of the foundations of the earth's crust along the line of this valley; or to lateral thrust from the south-east, sustaining or lifting the rock along the south side of the faults.

The former cause has some color of support from various considerations. The valley along the south side of which these faults occur is one of great antiquity, and is itself, in part at least, due to a sinking of the rocks along the course of the valley in ancient times. This sinking between Mill street and the Falls, along the Straight Shore amounted to three thousand or four thousand feet in past Geological ages. The wearing of softer rocks will not account entirely for the scooping out of the valley, as the hard flags of the Johannian division are found in the bottom of it, and the soft slates of the Bretonian division crown the Hospital hill on its south side. But though there are thus plausible reasons for supposing the faults may have been produced by a sinking of the earth's crust beneath the valley, those that favor the view that the faults were produced by lateral pressure from the south, seem more weighty.

This lateral pressure has been shown to exist at Monson, Mass. In the quarry at that place it has been found that after the removal of a block of stone, the rock on each side of the space from which this block was taken, would, in the course of a few hours, creep together considerably, showing that there was a tension of the rock in this quarry, indicating a pressure from the south.* The well-known case of the flexures on a gigantic scale in the Carboniferous and pre-Carboniferous rocks of the Alleghany ranges show that such a pressure has been in active operation from a south-east direction in the middle states since the Carboniferous period. The prevailing south-east dip, and the numerous monoclines, dipping in that direction, among the pre-Carboniferous rocks of Southern New Brunswick, all point to the former action for intense pressure from the south-east. And it seems probable that the continued action of the force, to which this pressure is due, in a milder form, is responsible for uplifts on the south side ot these pre-glacial faults.

The force which has produced these post-glacial faults appears to correspond in its action to that which caused the tension in the Monson quarry, only that in the case of the St. John locality it seems to have operated from a somewhat different direction. At St. John the greatest throws, and the most frequent, have a north-east to south-west course, and the more the joints depart from this course the less is the rock on their sides displaced; so that at right angles to this course a fault is quite rare.

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* The above was written from memory. I think the "Phenomena observed in quarrying," by Prof. W. H. Niles, described in American Journal of Science, March, 1872, refers to this occurrence. Among other peculiarities it was mentioned that a block split off with wedges 354 feet long, eleven feet wide, and three feet thick, freed at one end, but not at the other, was observed soon after being split to have lengthened one inch and a half; the expansion was not due change of temperature.

As the hade of these faults have more or less inclination to the south-east, the tendency of a force acting from the south-east (by lateral pressure) would be to elevate the mass on the south-west side of the fault and depress it on the opposite side. By continuous action of this kind a series of faults with an up-throw on the south side would be produced, which, in the width of this hillside, must amount to several feet.* Looked at in this view this whole hillside is a mass of shattered slate, seamed with joints, and ready to yield to pressure when applied; and when we consider that these post-glacial faults have been seen at other points, we realize that a stupendous power is still at work crushing and squeezing the rocks along this Atlantic coast, and ready to inaugurate afresh the process of mountain building when opportunity is afforded.

That this region is not perfectly stable and at rest may be inferred from the slight earthquake shocks felt here from time to time. Some of these shocks have had their area of greatest intensity at the mouth of the St. Lawrence river, and appear to have been propagated from there. The earlier records mention shocks of considerable violence, but the later ones have been slight.

The most complete list and description of these earthquakes which the writer has seen is that compiled many years ago by Sir William Dawson for the Canadian Naturalist, and is a record of about eighty-eight occurrences of this kind which have effected Eastern Canada and New England.† Of these at least twenty were probably felt at St. John, N. B., but only four are recorded in this list as having actually been felt here.

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* A further test of the source of this movement might be obtained by examining steep hillsides sloping to the north-west, and noting if the faults are more prevalent there than in other situations.

† Can. Nat. and Geol., October, 1860, Montreal.

Two later earthquakes are recorded by Sir William as having affected the Maritime Provinces.* These are said to have been powerful enough to shatter walls, throw down chimneys, and do other similar damage. Other earthquakes of slight intensity have occurred in this region since 1870, but I have not at hand the record of the time of their occurrence, or the areas affected by the shocks.

As collateral to this subject I may mention the existence of two objects in the museum of the Natural History Society of New Brunswick which appear to show earth-movements since the glacial period: One is a glaciated boulder from the Grand Falls of the St. John river, collected and presented by R. Chalmers, that since its entombment in the boulders clay has been broken apart, the pieces somewhat displaced and then re-cemented. The other, which indicates more recent fracture, is a stone lance-head of felsitic material found at Grand Lake, which, since it was originally lost in the debris of a camp site of the stone age, was broken apart, the pieces slightly displaced, and the lance-head again cemented so as to be as perfect as before, except for the line of the crack and the slight displacement where the pieces are joined.

A short notice of these pre-glacial faults has been communicated to the American Journal of Science. It is to be hoped that the members of the Society will examine the surfaces of ledges in other localities to find out whether the phenomenon of glacial faults is of common occurrence in other parts of the province.

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* Can. Nat. and Geol., 1891, also November, 1870.

ARTICLE IV.

THE OUTLETS OF THE ST. JOHN RIVER.

By G. F. Matthew, D. Sc., F. R. S. C.

Read 13th November, 1894.

INTRODUCTORY.

Among the many rivers of the Atlantic seaboard of North America none have the peculiarities which serve to give especial interest to the St. John.

It is difficult to find a river four hundred and forty miles long and only two hundred feet wide at its mouth,† or with the peculiar tidal rapids which give such constant variety to the appearance of the gorge at the narrow outlet of this river.

The St. John differs from the majority of rivers in having no marine delta; the mud which it pours into the sea being swept up and down the Bay of Fundy by strong tides, until it mostly finds a resting place in the deep waters of the bay, off Grand Manan and the Western islands. The actual delta of the St. John is inland, between Belleisle bay and Oak point, and of the Kennebecasis at Perry's point, where these rivers discharge into lake-like expansions of brackish water.

The St. John combines within its basin three different river systems, once independent of each other, but now contributing their waters to the stream which discharges at the harbour of St. John. The rivers of the Middle and Southern States flow with a rapid course from mountain ranges to the plains, where they enter the sea by broad estuaries; those of the New England States descend from a broken country to enter the sea by fjords, or by shallow estuaries; the Hudson alone dividing these two groups of states has physical features which may be compared with those of the St. John. These streams are alike in their long, navigable courses, and in the fact that each drains a flat, interior region and forces its way to the sea through obstructing ranges of hills. The St. John, however, flows through a rolling and elevated country before it reaches the interior plain, while the Hudson gathers its waters off the low plateau or plain of Central New York, and then passes directly through the hills to the sea.

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† Between Split Rock on the eastern side and the limestone point under the Cantilever bridge on the western side, according to W. D. Matthew, the width is about 212 feet.

I do not propose to discuss this evening all the features of this remarkable river, but rather to try, if possible, to throw some light on the question of earlier outlets of the St. John than that which now exists, and to sketch the genesis of the several valleys which now form the channel by which the waters of the interior are poured into the sea at St. John.*

Inception and Growth of the Valleys near the Outlet.

To trace the history of the valleys which give passage to the St. John, near its mouth, will carry us back to the remotest period of geological history, almost to the dawn of life, quite to that dawn as measured by the standard of fifty years ago.

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* J. W. Bailey has lately published a little book on "the St. John river, specially intended for sportsmen and tourists, in which the physical geography of this stream and its affluents is graphically presented. ("The St. John river in Maine, Quebec and New Brunswick," Cambridge, Mass., 1894.)

Let us take up this history at the close of Huronian time. At this period only the simplest organisms existed, viz., the Protozoa and Sea-weeds, with, perhaps, marine worms. The Protozoa had developed several types, as Sponges and Radiolarians with siliceous shells or skeletons, and the Foraminifera with calcareous shells, and these, no doubt, were accompanied by soft-bodied animals which have left no trace of their existence in the solid rocks. These animals that we speak of are known to have existed as early as, and probably before, Huronian time.

Huronian time in this region was too troublous to admit of the peaceful existence of these minute and delicate creatures. It was here a time of great physical disturbance. The solid crust of the earth, perhaps then more unstable than now, was broken up in many places and gave passage to great eruptions of volcanic matter. All the coast region of New Brunswick was overspread with vast sheets of scoria and ashes, poured forth from numerous volcanic vents.

Very noticeable among these volcanic ranges are the Kingston hills, now sunk to four hundred or five hundred feet above the sea level, but once towering above the surrounding country. Usually the rocks of this old volcanic range are so twisted and folded, or broken up, that it is impossible to trace the order of succession in which they were laid down; but at New river, in Charlotte county, they are more regular, and there a succession has been traced amounting to ten thousand feet in thickness. This means an accumulation of more than a mile and a half in thickness of lavas.

But the peculiar feature of this Kingston range is that while it has a longitudinal extent of about seventy miles, from Beaver harbor to Norton, where it is covered by later deposits, it is only four or five miles wide; and it is bounded by nearly straight lines throughout. This tells us that there were profound faults or breaks in the earth's crust along each side of this range, with probably a sinking area between, into which and on which the lava streams were poured. These faults were the initial lines of valleys which continue to exist to the present day.

A glance at the condition of these valleys, as they were developed during the passage of the ages, may be of interest. But we can only refer to a few of the more important epochs, taking up first their aspect at the close of the Cambrian time.

The Huronian epoch, previously referred to, was marked by the existence of animals of low organization —the Protozoans; now an advance had occurred, and we find the seas were tenanted by Crustaceans and Molluscs of various kinds, as well as many soft animals which have left tracks on the surface of layers of sand and mud of which the rocks are made up. The volcanic fires had died out, the sea had covered the land in the region of which we speak, except, perhaps, a few projecting hills; and over the lava beds, sunk beneath the ocean, was spread layer after layer of sand and mud, charged with the cast off tests of trilobites, the shells of molluscs, and the rod or net structures of hydroids.

THE SAINT JOHN FAULT.

The muds in which these were buried accumulated to a thickness of four thousand feet, and subsequently were crowded and folded together by a resistless pressure from the south, until the whole series was at one point doubled over on itself. This over-folding has revealed the existence of another profound fault in the earth's crust within the city limits; it runs along the Marsh and Valley, and the upper part of the harbor, from Mill street past the Straight Shore to the Lunatic Asylum, and beyond. (See map on page 56).

On the south side of this great fault the earth's crust has sunk down to the depth of three-quarters of a mile; or, *vice-versa*, the crust on the north side has risen to that extent, and the covering of Cambrian rocks with its entombed trilobites, molluscs and graptolites, or hydra-like animals, has been completely swept away by the vast denudation of subsequent ages. The weakness of this fault line helped to produce the valley which now exists along the City Road, and the upper part of the harbor which here forms a part of the outlet of the St. John.

DENUDATION AS WELL AS FAULTING HAS HELPED TO FORM THESE VALLEYS.

Another part of the outlet is more clearly the result of denudation or wear of the rocks. In the Laurentian rocks which cross the river at the "Falls," or rapids, there are some bands softer than others. One of the soft bands is that of shales, etc., which contains the graphite beds; this band is enclosed between limestones on the south and quartzites on the north, and being softer than the enclosing bands has given rise to the basin between the Upper and Lower "Falls." The quartzites on the north, form the ledges which obstruct the passage of the water of the river at the "Upper Falls," and the limestones on the south form cliffs on each side of the gorge at the "Lower Falls." On the west side of the river no rocky ledges show between these points, but the shore consist of Boulder clay and other surface deposits.

More complex agencies have been at work in producing the undulating shore lines at and opposite Indiantown, chiefly the denudation of rocks of unequal hardness, and the movement of rocks along fault lines. The bold hill at Pleasant point is a mass of granite which has fault lines and softer beds on the south, and softer strata also on the north, and to these owes its prominence; and the deep indentation of Marble cove is clearly due to the softer limestones and slates which lie between the harder quartzites on the south, and the granite, quartz-diorite and gabbro of Indiantown itself.

In the Narrows above Indiantown the rocks are of so uniform a texture that denudation cannot have been the chief agent in producing this somewhat tortuous passage. We shall have to appeal to cross-faults here for an explanation of the inception of this passage, though subsequent wear by water-action no doubt enlarged and deepened it.

The formation of caves and subterraenan water courses in the limestone beds in distant ages, (as suggested further on) are also probably in part responsible for the opening up of this passage.

ENLARGEMENT OF THE VALLEYS BY DEFORMATION OF THE EARTH'S CRUST.

The occurrence of these faults leads us to speak of the enlargement of the valleys above the Narrows, to which we have already referred, as being due to profound faults produced in Huronian and post-Cambrian time in the earth's crust. We may now take a step onward in time and look at this region at the close of the Devonian period.

Important physical changes had taken place; the comparatively peaceful condition of the region in the Cambrian ages had been followed by volcanic disturbances, not however on the vast scale of those which took place in the Huronian age. But though the volcanoes were less active the tangential pressure from the ocean became more intense, and finally culminated in the extrusion of extensive areas of granite. These movements were complicated with the production of new fault-lines and changes of level along the old ones.

In Cambrian times the movement along the two great faults that bound the old volcanic range of the Kingston rocks was reversed from what it had been in Huronian time, and the valleys which were thus formed on each side of the Kingston ridge were filled with Cambrian sediments. Another fault line had formed along the northern rim of the valley on the north of the Kingston ridge, producing a parallel valley in which Upper Silurian muds were deposited.

It was probably at this period, that is to say at the close of Devonian time, that the great cross fault was formed, which extends from the granite in the Nerepis hills to the Narrows of the river above Indiantown.* This fault, enlarged into a valley, of which the Nerepis intervals, the Short Reach and Grand Bay form parts, serves to catch the waters of the rivers coming down the long valleys to the eastward and convey them to Indiantown.

GROWTH OF THE KENNEBECASIS VALLEY.

One more stage in these profound earth movements may be referred to. If we pass on to the close of Carboniferous time, although there are proofs of comparatively mild volcanic action in the interior of the Province of New Brunswick at this time, no physical change occurred in the region that can be compared to the vast volcanic outbursts of the Huronian, or the great pressure and metamorphism of Devonian time. Nevertheless, there are proofs of some important movements along these old fault lines. I should especially refer here to that which bounds the south side of the Kingston hills, and therefore the north side of the Kennebecasis valley.

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*The continuity of this fault line is broken by the granite ridge of Pleasant point, opposite Indiantown; but W. D. Matthew informs me that this granite is traversed by numerous trap dykes (diabase), parallel in their course to the Short Reach fault.

At this time the chain of hills between this valley and that of Loch Lomond was of much greater height than it now is, and perhaps was glacier-covered. From these highlands a vast body of material was swept into the valley below, and with the wash from other sources accumulated to a depth of several thousand feet. At the Joggins, in Nova Scotia, this Carboniferous formation, or terrain, has a thickness of fourteen thousand feet, but in our region the thickness probably was not so great. Whatever it was, however, the weak line of the crust along the foot of the Kingston hills could not sustain it, and it sank gradually its whole thickness along this fault-line. Subsequent denudation scooped out a good deal of these soft beds and produced the present valley.

There are indications that the great cross fault of the Short Reach yielded somewhat at this time, sinking on the East side; for while the Carboniferous deposits show considerable bulk at Boar's Head and Kennebecasis island, they are hardly represented on the west side of the river. The Cambrian sediments also east of this fault, in the Long Reach valley, are much better developed, that is, have been less eroded, than they have west of it.

ESTIMATES OF GEOLOGICAL TIME.

As yet, however, there was no St. John river; the changes in, and denudation of the earth's surface which I have endeavored to describe, were simply the stages which led to the production of the valleys which this river, in a later period of the earth's history, utilized for its outlet.

The principal features of this river basin were chiselled during a vast space of time, of which no record remains in this region, except the worn and corroded surface of the earth, exposed to the action of the elements during a succession of ages. Geologists have attempted to estimate what the extent of this time was, or at least the relative length of its different parts. The space of time, from that when the Huronian volcanoes ceased to pour out their vast floods of lava until the close of the Carboniferous age (Permian included), is called the Palæozoic ages, and it is represented by nearly consecutive deposits in this region, which give us the history of geological changes occurring here during this time.

The next grand division of time includes the Mesozoic ages, and so far as the St. John river is concerned is an utter blank, no vestige of a formation or terrain remains on the banks of this river, to tell of the changes which then occurred.

The third great division of Geologic time includes the Cainozoic ages, and is also a blank as regards these Maritime provinces, except its closing period, represented by the deposits of the Glacial and subsequent times.

Some of the leading American geologists have given time ratios, to mark the proportionate lapse of time during these geological ages, as follows:

	Palæozoic.	Mesozoic.	Cainozoic.
J. D. Dana, ...	12	3	1
A. Winchell, ...	9	3	1
H. S. Williams, ...	15	3	1
C. D. Walcott, ...	12	5	2
Average, ...	12	3½	1¼

Williams' and Dana's estimates were based largely on observations in the eastern United States; Winchell's, on studies in the north-central States; Walcott appears to have given more weight to the evidence obtained in the western States, where the Mesozoic and Cainozoic rocks prevail. I should be inclined to think his proportions nearer the truth, as they accord better with European estimates of the comparative length of the several great divisions of geological time.

Walcott has gone further and given us an estimate by years of these several great divisions of time, allowing nearly one and a half millions of years to each unit of the time ratios. Taking his estimate we may say that for ten millions of years, during which vast changes in the life history and physical conditions of the globe took place, the record here is a complete blank. During most of the time it probably was for this region a period of continental elevation, when the rivers cut deep canons and valleys into the earth's crust, and when the ocean margin was far off to the south, along the outer banks which exist on the Atlantic coast, from Nantucket to Sable Island. This was the period of the carving out of valleys by flood and storm in preparation for the needs of the St. John at a later time.*

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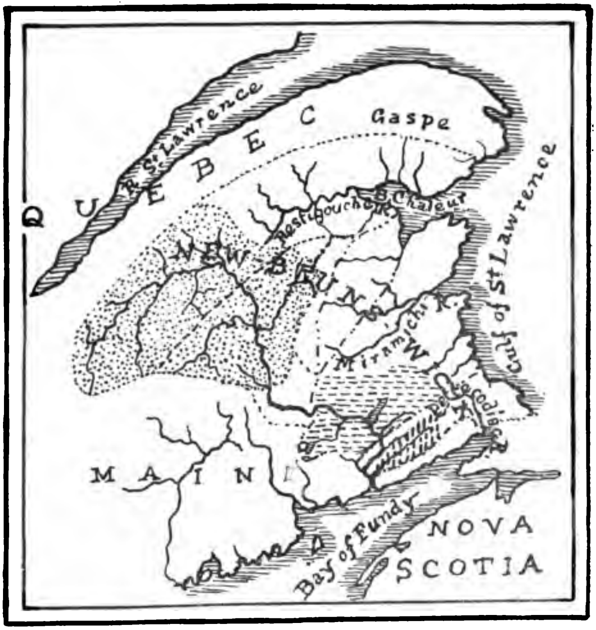
* The Continental border at this period in New England is indicated by beds of sand, gravel and clay of considerable extent and thickness in Long Island, Martha's Vineyard, Nantucket, and the shoals eastward of this island; and though thinner deposits in shallower estuaries and lakes were no doubt formed contemporaneously further to the north, they have been comparatively thin and have been almost entirely swept away by subsequent sub-aerial erosion. Small patches of sediments of the Cretaceous period have been found in Massachusetts, of the Tertiary in Vermont, and again of the Cretaceous in Wisconsin and Minnesota, on the borders of this Continental area. But on the whole it would be safe to assume that during the long Secondary and Tertiary ages (Mesozoic and Cainozoic) that elapsed after the Trias and before the Glacial period, New England and all Eastern Canada was above the sea, and at times of greater extent and height than now.



DRAINAGE AREA OF THE ST. JOHN.

Showing the portions of other river-systems that have become tributary to it:

············	**Boundary of the Restigouche basin.**
⁘⁘⁘⁘⁘⁘	**Portion which has become tributary to the St. John.**
—··——··—	**Boundary of the Miramichi basin.**
– – – –	**Portion made tributary by the St. John.**
—···—···—	**Water-shed between the St. John and Miramichi rivers.**
ǀǀǀǀǀǀǀ	**Portion of the Petitcodiac basin now tributary to the St. John.**

THE RIVER SYSTEMS WHICH COMBINED TO FORM THE ST. JOHN.

I have said that the St. John was a combination of three river systems. (See map on page 53.) Of these the northern is that of the Restigouche, and embraces a large area in the north of New Brunswick and Maine, which was a sound of the sea in Silurian times. In later Devonian times the sea had withdrawn nearly to the present Baie Chaleur, but it again invaded the valley along its southern side as far as the Aroostook valley, at the beginning of the Carboniferous period. The deformation or change of level of the surface of this valley, which drew off the waters of its western part in a southerly direction, which now are tributary to the St. John, probably took place during, or after, the Carboniferous period.

Between the Silurian age, when this valley was filled with marine sediments, and the beginning of the Carboniferous period, the strata were folded and uplifted along this valley, and through the hills on its southern side ridges of granite were brought to the surface. The depressing of the south side of the valley was subsequent to this, and went so far as to carry this side beneath the sea again.* Scattered areas of red sandstone and conglomerate in this area were deposited at this time.

The middle river-system may be regarded as that of the Miramichi, since this river now drains away to the eastward, the principal waters of this system. As it existed at the close of Carboniferous time, this system included all the central part of New Brunswick, a wide plain, opening and descending to the eastward, and its western border is now marked by the Carboniferous rocks which extend westward to, and include Oromocto lake.

The third river system which the St. John made tributary to itself, or of which, perhaps, it would be more correct to speak as the original St. John, is that which flows in the Kennebecasis and Petitcodiac valley. It is one which apparently, in the early part of the Carboniferous age, had its discharge eastward; but which, after the long period of continental uplift, if not earlier, through the breaking down of the land barriers near St. John, found an outlet to the south.

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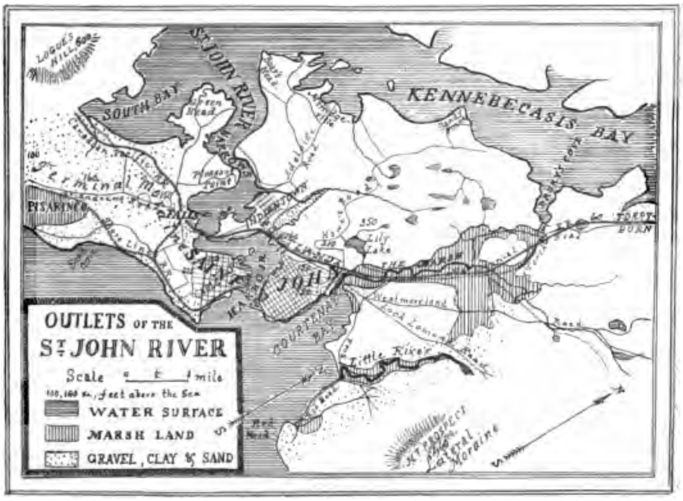
* See the triangular area on the map, divided off by a line of dashes.

Thus we see that the St. John river has attained its present magnitude by the breaking of mountain or hill-barriers which once separated its three river systems, and is not a simple valley of continuous growth like the Mississippi. Great changes of level of the earth's surface were required to bring about this condition of things, and these changes were to a large extent affected during the period of continental elevation to which I have referred. Not all of them, however, for very important ones were produced when the former warm-temperature climate was exchanged for one of arctic cold, and glaciers of wide extent overspread the land.

Action of Glacial Agencies Upon the River Courses.

The long period of continental elevation, coupled with the warm temperature which prevailed during the greater part of it, had decomposed the rocks to a great depth, and when glaciers invaded the land they found it an easy task to remove great masses of this loose covering. This debris was carried along by the moving ice and eventually deposited at the sides and at the foot of the glaciers, across many of the valleys and ravines, and left there when the ice melted away. These deposits were modified during a period of submergence, but not greatly changed, and as the land again arose to its original level, first beds of sand and gravel and then beds of clay were deposited in all the valleys, forming a luting which made water-tight the numerous basins formed by the transverse moraines and gravel ridges that existed in these valleys. In this way innumerable lakes were produced, and it became the business of the rivers, as the land emerged from the sea, to unite the various lakes together, to erode the barriers, drain the depressions and restore the river systems again.



It sometimes happened that these gravel and boulder-clay barriers were so extensive and high that the river was forced to seek a new channel, and usually a rocky one, often removed to a considerable distance from the one it had occupied before the Glacial period. Such was the case with the St. John, both at Grand Falls and at its present outlet.

The conformation of the land between South bay and Pisarinco cove renders it highly probable that this was the course by which the river discharged its waters into the sea before the Glacial period. The shores are low around both these indentations, and only a few ledges come to the surface in the intervening area, which is occupied by Boulder clay and gravel ridges, with a covering of Leda clay in the hollows. Every indication points to the existence of a buried channel of the river somewhere between the Asylum ridge and Robinson's inn, on the St. Andrew's road.

FOUR OUTLETS OR PASSAGES ONCE EXISTED.

The Glacial period was followed by a time of submergence when all the land around St. John was buried beneath an icy sea. After a time these conditions were reversed and the land rose again, so that the ridge dividing the interior region from the Bay of Fundy began to show itself. The sea stood at a much higher level then than it now does, and instead of the brackish-water basins within the barrier at Indiantown, which now exist, there were land-locked salt-water basins, sheltered like Passamaquoddy bay at the present day, from the ocean-swell and the storms of the bay of Fundy.

When the sea had retired so far as to leave bare the tops of the hills which are now one hundred and fifty feet above its present level, the existing outlet of the St. John began to be defined by a wide estuary, extending from Logue's hill in Lancaster (600 feet high *) to Mt. Prospect (the "Cottage Hill") in Simonds (440 feet high). The inhabited part of the city was still beneath the waters of the bay of Fundy when the opening of this estuary was dotted with numerous islands, now the tops of hills, in the peninsula between the harbor and the Kennebecasis, etc. Beside the present outlet of the river there would at this time have been three others. The most westerly of these passed out from South Bay by way of the valley of

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* For the heights given in this paper I am indebted to Wm. Murdoch, C. E.. Engineer for the Board of Works of the city of St. John.

Spruce Lake stream to Pisarinco cove, and was about fifty feet deep; another on the opposite side of the estuary passed through Torryburn valley and was nearly a hundred feet deep; and a third, a deeper, but narrower strait, existed at the present site of Drury's cove.

As the land continued to rise the depth of water in these passages diminished, until two of them were entirely closed and only the present passage and that at Drury's cove remained. This cove is a deep indentation of the Kennebeccasis river, here a lake-like expansion connected by a deep water channel with the St. John, and filling the lower part of the valley in which the former river runs. The cove is enclosed by rocky shores, but at its head there is a low pass — only about fifteen or eighteen feet above high-water mark—and floored by limestone ledges. This pass connects the cove with a long narrow valley, now filled with marine alluvium called the "Marsh," which has its termination at Courtenay bay, east of the city, and thus connects with St. John harbor.

When the land rose so that the sixty feet beach was formed, the Torryburn passage would have been closed, but there would still have been a channel forty feet deep at Drury's cove and one of equal or greater depth at the present passage.

From the condition of the Marsh valley it seems probable that the Drury's cove outlet continued to exist for some time after this, as the land continued to rise; this it did until the sea-water was entirely excluded from the Kennebeccasis and St. John rivers. When nearly excluded a tidal flow of considerable importance would have existed at Drury's cove as well at the main passage at the falls, and only the rocky floor at the former outlet and the narrowness of the pass would have prevented this passage from being as important an outlet as the other. From this acuse, however, if from no other, the passage at the falls would gain the preponderance and finally become the sole discharge of the river.

Not only was the sea-water thus excluded from the river by this rising of the land, but the harbor itself was probably drained so that an outer fall appears to have been formed to the eastward of Partridge island.* At this time the Drury's cove passage was closed, and peat and marsh mud began to fill in the valley of the Marsh. The land then began to sink again, but very slowly, until it reached its present level, and the tidal falls were re-established as we now see them.

Marine alluvium is, as we know, one of the latest of the geological deposits, and is in process of accumulation at the present day. The growth of this deposit in the Marsh valley has been stopped by dyking the outlet of the valley, but the deposit where it has been tested shows a very considerable depth at several points, and occupies the place of an old water channel that has been silted up in comparatively modern times. It no doubt had its origin in the period of continental elevation, or at least was enlarged at that time and very likely was in connection with some old water-way, possibly subterranean, that crossed the limestone ridge which separates this valley from the Kennebecasis. Indications of old subterranean channels in this ridge are found at several points. I may instance two.

*** The former existence of this fall is shown by a rocky depression which exists south-east of Partridge Island and is indicated by the soundings there; outside of this the old submerged channel of the river has been filled up by the silt which is swept up and down the Bay of Fundy by the heavy tides.**

SUBTERRANEAN WATER-WAYS.

The first I shall refer to was along and beneath the valley in which the Intercolonial railway runs, and is marked by limestone sinks at several points. One of these is west of Torryburn station, the next is Lawlor's lake. It is difficult to account for the deep cup-like form of this lake, surrounded by steep hills of limestone, on any ordinary theory of erosion by surface-wear, and we suppose it to be due to the undermining of the rock along pre-glacial subterranean water-courses. A third sink on this line is south-west of Lawlor's lake. The present drainage of the two western sinks of this valley is discharged by a spring at the head of the "Marsh," at the level of the marine alluvium, the spring being blocked at this level by the marshy deposit.

The other instance of an old abandoned channel in the limestones is Oliver's cave, on Howe's road. No stream runs near this cave now, but close by, to the north-east, lying in a valley opening north-eastwards to the Kennebecasis, occupied by several lakes, is a small pond, called Dark lake, which discharges by an underground passage into the valley of Simond's marsh. The stream through this valley enters the St. John river just above Indiantown. The valley of this stream is considerably lower than Dark lake and the outlet of Oliver's cave, opposite those places, and is filled at this lower level with an alluvial deposit, probably resting on Leda clay. Oliver's cave consists of a descending passage and two chambers, and terminates in a well, filled with water to the depth of the surface of the alluvium in the valley adjoining. It is evident that the water-channel formed through the limestone rock at Oliver's cave is a very old one and has been blocked during a period of submergence by the deposit formed in this valley.

I refer to these two instances to show the possible existence of buried subterranean channels in the limestone ridge which may have given passage to more or less of the river-water of the Kennebecasis, and of the St. John valley, in pre-glacial times.

CHANGES OF LEVEL DUE TO POST-GLACIAL FAULTS.

But there is an element of uncertainty as to the comparative importance of the passage at Drury's cove and that at the present outlet, due to a cause which we only lately been led to appreciate. This cause, which may have operated at only a late date to close this channel, would have acted by an uplift of the solid rocks at the Drury's cove pass, such as undoubtedly has occurred in the city of St. John itself since the Glacial period.

Is is but recently that we have observed the obvious evidence of such movements which exist around us. At our last meeting I called attention to the existence of post-Glacial faults in and near St. John by which very considerable changes of level in the surface of the land had been effected since the glaciers disappeared from this region. In one case a change of level to the extent of over five feet can be shown to have occurred in a space of one hundred and fifty feet. This movement was effected by a number of small faults or breaks in the rocks, amounting in all to the displacement above referred to. If the solid rocks could thus be lifted to the extent of five feet in the short space of one hundred and fifty feet, it is quite possible that between the sea and Drury's cove they may have been raised to the extent of fifteen or twenty feet. A rise of the ledge at that cove to this extent would prevent the escape of the river waters at that point and turn the whole into the present outlet.

In the preceding remarks I have not mentioned another cause which, no doubt, operated to deepen the present outlet at the expense of the one at Drury's cove when once the preponderence of the discharge at the former was established, namely, the erosion of the rocks at the "Upper Fall." I know of no evidence of this erosion which, nevertheless, is in progress at the present day; but it will be difficult to distinguish it from the effects of the slow subsidence of the land which has been going on in modern times, without special observations having this end in view.

CONCLUSIONS.

To sum up the whole matter we may say that—

1st. The St. John River is built up of three river systems, once independent of each other.

2nd. That the river has availed itself of several very ancient valleys for its present outlet.

3rd. That the pre-Glacial discharge was probably by a buried valley on the line of South Bay and Pisarinco Cove.

4th. That there were four post-Glacial outlets.

5th. That the post-Glacial outlet by way of Drury's Cove and the Marsh, to Courtenay Bay, persisted longer than two others of the four, but now only one of the four remains open.

APPENDIX A.

THIRTY-SECOND ANNUAL REPORT OF THE COUNCIL OF THE NATURAL HISTORY SOCIETY OF NEW BRUNSWICK.

The Council of the Natural History Society of New Brunswick beg to submit the following account of the condition of the Society and the work done during the past year:

MEMBERSHIP.

Addition has been made to the membership roll, as follows:

Ordinary members,	4
Associate members,	11
Junior member,	1
Corresponding member,	1
Total increase,	17

FINANCE.

The Treasurer's report shows the following receipts and expenditures:

Balance on hand from last year,	$205 09
Receipts from dues,	103 00
Bulletins sold,	1 05
Duplicate specimen sold,	10 00
Provincial grant,	125 00
Miscellaneous items,	6 34
	$450 48
Expenditures for year,	435 69
Balance on hand,	$14 79

SECRETARY.

The Secretary reports that during the year 119 communications were received and 145 sent. Communications received and forwarded have been filed and indexed in a book kept for that purpose.

All the old papers and documents of the Society have been collected, arranged in a large blank book and indexed. Many manuscripts of papers, read before the Society in its earlier years, have been placed for preservation in large envelopes and labelled.

LECTURES AND ESSAYS.

Nine regular meetings were held, at which the following papers were read:

1893.

Feb. 7. (1) Geography and Natural History of the Tobique. By Geoffrey Stead. (Published in Bulletin No. XI.)

(2) Spring Flowers about Fredericton. By F. G. Berton.

Mar. 7. (1) Notes on the Introduction of the Pickerel into New Brunswick. By Samuel W. Kain.

(2) The Black Bass Introduced into the Waters of New Brunswick. By Samuel W. Kain.

April 4. Constellations and the Planets. By Geo. U. Hay, M. A.

May 2. Sir James Alexander and his Survey from the Bend to Boistown. By Geo. U. Hay, M. A.

June 6. Report of Delegate to Royal Society.

Oct. 3. Account of Summer Camp held in August at French Lake. By Geo. F. Matthew, D. Sc., F. R. S. C.

Nov. 7. Geology and Mines of Eastern Cape Breton. By Geoffrey Stead, C. E. (Printed in *Progress* of November 13th, 1894).

Dec. 5. General Business — resolution on death of the Patron of the Society. No paper.

1894.

Jan. 2. The Red Indian of Newfoundland. By Dr. H. G. Addy. (Abstract given on page 71).

The Society also carried on its usual course of Elementary Lectures in Science, which was well attended and very successful. The subjects were selected with special reference to the work of the Summer Camp, held in August at French Lake. Nine lectures were given, at which the following subjects were treated:

1893.		
Feb.	14.	Land and Fresh-water Molluscs. By Geo. F. Matthew.
	21.	On the Palæolithic Age, or Age of Chipped Stone. By Geo. F. Matthew.
	28.	On the Neolithic Age, or Age of Polished Stone. By Geo. F. Matthew.
Mar.	14.	French and Indians on the River St. John. By Rev. W. O. Raymond.
	21.	The Structure and Habits of some of the Lower Forms of Fishes. By Philip Cox.
	28.	The Common Smelt. By Philip Cox.
April	11.	Some Observations on Plant Life. By G. U. Hay.
	18.	Some Observations on Plant Life (continued). By G. U. Hay.
	25.	History of Architecture. By G. Earnest Fairweather.

LIBRARY.

The Librarian reports that the number of exchanges received is in excess of any previous year. Special note is made of the receipt of thirty-seven numbers of the publications of the Manitoba Scientific and Historical Society.

Dr. John Baxter, of Chatham, donated a copy of Roderick McKenzie's "Miramichi Wild Flowers"—a desirable addition to our botanical works.

A new book case has been placed in the library, and has been utilized to hold the many scientific publications of the United States Government.

BOTANY.

The Botanical Committee report that a handsome Herbarium case has been obtained during the year and placed in the library.

The work of arranging our large collection of plants in this new case is progressing, and a catalogue is being prepared. When this is completed the Society will have a collection in which it may well take pride.

MUSEUM.

Some work has been done in the museum, but much remains. Additions are constantly being made by donations from members and otherwise. The Society is indebted especially to Messrs. W. M. McLean and P. Cox for the large addition made to our collection of fishes.

The collection of insects is the only collection in the museum that is catalogued, and the importance of having the other collections catalogued cannot be over-estimated. It is a considerable task, but if done in sections by the various committees, could be accomplished before the next annual meeting.

The rooms are open to the members on Tuesday and Friday evenings, and the museum to the public on Tuesday evening and on Saturday afternoon. Members are invited to come, as occasion offers, and study the collections. About one hundred and fifty persons visited the museum during the year.

PUBLICATIONS.

Bulletin XI. has been issued and placed in the hands of members and sent to the various societies, with which exchange is made. Many calls have been received from abroad for back numbers, and it is a matter of regret that the stock of earlier numbers has been exhausted. Any one who could supply copies of Bulletins I. to III. would confer a favor.

SUMMER CAMP.

In the earlier part of the year it was determined to hold a summer camp in August for the study of nature in the field, and the course of elementary lectures was arranged largely with that work in view.

In August the party, numbering about twenty-three, proceeded to French Lake, some by sail boat and some by steamer to McGowan's wharf, and thence by carriage to Lakeville Corner. Tents were erected and ten days were spent in studying the surrounding country. Excursions were made in all directions, and very satisfactory results were obtained in archæology and botany. The party secured many specimens of the implements and weapons of the unknown people who, in the Pre-historic period, dwelt in that section of the province, and the additions thus made to the museum furnish good material for students of this most interesting subject. By vote of the Society the President has been requested to edit an account of the camp for future publication.

GENERAL.

The University Extension movement has been continued, and in the latter part of the year Dr. Bailey, one of our honary members, gave an interesting course on Zoology in the rooms of the Society.

The Committee on Invertebrates report an addition to the museum of a collection ot Pacific Coast shells. This collection will amount to at least eighty species, and will be a valuable acquisition, illustrating, as it does, the marine shell fauna of the western shores of our Dominion. Some other shells have also been received as donations. A preliminary list of our native land and fresh water shells is being prepared by Wm. D. Matthew and G. Stead.

The Press Committee report that the press of St. John have granted free insertion of preliminary notices of meetings, and by excellent reports of the lectures have materially aided in disseminating information about the Society and its work. For those courtesies the hearty thanks of the Society are due.

At the last annual meeting some amendments were made to the constitution — enlarging the duties of the Secretary and giving the Associate members power to elect a President and Secretary of their branch.

The Council consider that the year now closing has been a prosperous one, and hope the members of the Society will continue to interest themselves in promoting the objects for which it was founded.

Respectfully submitted,

SAMUEL W. KAIN,
Secretary to Council.

Natural History Rooms, Market Building,
St. John, N. B., January 16th, 1895.

REPORT ON BOTANY.

Since the somewhat large list of plants recorded in the Bulletin of 1893 was published, very few plants have been found that are new to the province. The researches of Mr. M. L. Fernald, of Cambridge, Mass., in Northern Maine and New Brunswick have brought to notice some plants new to the province. Others, which Fernald found only in Northern Maine, may be looked for in New Brunswick. Mr. Fernald suggests that New Brunswick botanists are in a place to be of great service to him in his Maine work, particularly when they note (as he has done) things on "the other side of the line." Our New Brunswick botanists will, no doubt, readily accept this offer of reciprocity, if opportunity should occur. Among the interesting plants discovered by Mr. Fernald are the two varieties of *Nuphar advena; Oxytropis Lamberti*, Pursh, var. *sericea*, at Van Buren, Me., ("its first appearance east of Montana"); *Pyrus sambucifolia*, "growing with and as common as *Americana; Myriophyllum alterniflolium*, *M. verticillatum*, *M. ambiguum*, *M. tenellum; Epilobium adenocaulon; Potamogeton nitens* ("a very rare plant, having been found but once before in America, should be looked for about Edmundston,") *Carex interior; Panicum nitidum; Glyceria grandis; Equisetum littorale, Woodsia obtusa* (Van Buren).

Mr. Vroom reports *Lobelia cardinalis* on south branch of Oromocto, near Fredericton Junction—farther east than before noticed.

ADDITIONAL REPORT.

Mr. Brittain reports *Lysimachia lanceolata*, found near St. Stephen in 1891 by Mr. G. A. Inch. Mr. Brittain also reports receiving a specimen of *Aster linariifolius*, found by Mr. Edward Jack at Boiestown, in Sept., 1894.

Mr. Hay reports *Cuscuta epithymum*, var. *trifolii*, a very injurious weed from Europe. Found at Ingleside, near Westfield, October, 1894, twining about clover, very abundant in one corner of a field belonging to Mr. Finley, who ploughed it under.

G. U. HAY,
Chairman of Committee.

THE RED INDIAN OF NEWFOUNDLAND.

(Abstract of a paper read January 2nd, 1894, by H. George Addy, M. D.]

Dr. Addy, in introducing his subject, gave extracts from the writings of the early explorers of Newfoundland referring to the aborigines of that country.

A graphic picture was drawn of the happy and primitive life of these people when the Cabots visited Newfoundland, and the sad story of their cruel extermination was briefly told.

Mr. Cormack was the first white man to cross the island, and he reported these Indians to be a fine, hardy race of men, subsisting by the chase and living a simple life.

Richard Whitbourne, in his work on the island, (published 1622) thus describes them: "The natural inhabitants of the country, as they are but few in number, so are they a somewhat rude and savage people, having neither knowledge of God nor living under any kind of civil government. In their habits, customs and manners they resemble the Indians on the continent, from whence, I suppose, they came. They live altogether in the north and west part of the country. The French (who resort thither yearly for the whale fishing and also for the codfish) report them to be an ingenious and tractable people, being well used."

After quoting in detail various authorities to account for the origin of the Red Indian, he summed up the evidence to show that they were the vanguard of the Algonquin tribes, driven to the extreme eastern coast by succeeding waves of immigrants from the shore of Asia and the islands of the Indian Archipelago.

The territory occupied by these Indians was then described. It contained about 4,000 square miles, and embraced the region bordering on and between the Exploits and Humber Rivers.

An account was given of their ingeniously constructed fences for entrapping deer, their dwellings, mode of preservation of food for the winter, and their canoes and weapons.

Dr. Addy concluded his interesting paper with an account of their burial customs.

DONATIONS TO THE MUSEUM.

DATE.	DONOR'S NAME AND DESCRIPTION OF ARTICLE.
1893.	
Jan'y	W. F. BEST, ESQ.—Asbestos and the rock in which it occurs, from the Black Lake Mines, Quebec.
Feb.	EXHIBITION COM.—Bamboo from Demarara.
May.	JOHN S. MACLAREN, ESQ.—Scales of Tarpon.
	JOHN S. MACLAREN, ESQ.—Large grooved stone axe found at St. Leonard's Flat, Madawaska County, N. B.
	HAZEN J. DICK, ESQ.—Lizard from Luzon, Phillippine Islands.
June.	JAMES CLERKE, ESQ.—Unfinished maple shoe-last, with full grown insect enclosed (*Clytus speciosus*).
	J. MORRISSEY WHITE, ESQ, Bathurst.—Blue Heron.
	MR JOHN. V. ELLIS, JR.—Eider Duck (mounted).
	GEOFFREY STEAD, ESQ.—Archæozoon Acadiense, three specimens from Douglas Road, St. John, N. B.
August.	DAVID PELMAIN, ESQ., Indian Point, Grand Lake.—Three stone spear heads, four arrow heads, and one piece of Indian pottery.
	DUNCAN LONDON, ESQ., Lakeville Corner, Sunbury Co.—Small stone axe, carved arrow point and flaked knife blade.
October.	SUMMER CAMP PARTY.—A large number of stone axes, arrow heads, sinkers, skinning knives, spear heads, and other articles of stone; also fragments of Indian pottery; stone implements mostly from French Lake and vicinity; pottery from Indian Point, on Grand Lake. (105 articles of stone, 97 pieces of pottery).

Donations to the Museum — (*Continued.*)

Date.	Donor's Name and Description of Article.
1893. *October.*	**Mrs G. A. Hamilton.**—Fifteen species of tertiary fossils, four specimens of phosphate, and an electric swamp-bug, from Ocala, Fa.
	J. T. Moriarity.—Squid from St. John Harbor.
	W. E. Stevens.—Great spotted Salamander from Lily Lake, St. John, N. B.
	Dr. Geo. A. Hetherington.—Harbor Seal (mounted).
	W. R Raymond, Esq.—Moose bone.
	Fred. Pickett, Esq., Greenwich Hill, Kings Co.—Cray Fish (*Cambarus Bartonii*).
Nov.	**Dr John Baxter**, Chatham, N. B.—Seventeen specimens of Mollusca from Tracadie Beach, embracing nine species.
	Geoffrey Stead, Esq — Fossils from coal measures of Eastern Cape Breton, consisting of ferns, calamites, fish scales, bivalve crustaceans, *Naiadites elongata*, etc. Twenty-one specimens in all.
	W. J. Wilson, Esq, Ottawa.—A fine collection of Devonian fossils from the Fern Ledges of Lancaster, consisting of ferns, fruits, *Asterophyllites*, etc.
	Geoffrey Stead, Esq — Concretions from recent clay found in bank of St. John River, four miles above Fredericton. Fresh-water Clams (*Unio* and *Anodon*) from Grand Cane, La., U. S. A. Twenty-eight specimens, embracing twelve species.
Dec.	**Geo. Robertson, Esq**, Mayor of St. John.—Six Bamboos, fifteen feet long and from three to six and a half inches in diameter, from Jamaica.

DONATIONS TO THE LIBRARY.

DATE.	DONOR'S NAME AND DESCRIPTION OF BOOK.
1893.	
Jan.	Director Experimental Farms, Ottawa.—Reports 1887 to 1892. Bulletins 1 to 18.
Feb.	Ottawa Field Naturalists' Club, Ottawa.—Proceedings, Vol. VI, Nos. 10, 11; Vol. VII, Nos. 1-9.
	Department Marine and Fisheries, Ottawa.—Twenty-fifth Annual Report. Report on the Oyster Fisheries of Canada, 1892.
	Hon. L. J. Tweedie, Surveyor General of New Brunswick.—Report Crown Lands Department, 1883 to 1892. Map of New Brunswick (Loggie's).
	Feuilles des Jeunes Naturalistes, Paris.— Nos. 268 to 278.
	American Museum of Natural History, New York.—Bulletin, Vol. IV., 1892.
	Inland Revenue Department, Ottawa.— Bulletins 31 to 33.
	Russian Geological Survey, St. Petersburg.—Bulletins, Vols X. and XI.; Memoires, Vols. XI.-XIII.
	Public Museum of City of Milwaukee, Milwaukee.—Tenth Annual Report.
	U. S Department of Agriculture, Washington. —Circulars 8 and 9. (Forestry Division). Bulletins 1-6. Annual Reports, 1886-1891 (Forestry Division). Hawks and Owls of the United States, by A. K. Fisher. Bulletin No. 4. The Prairie Ground Squirrels, 1893. North American Fauna, No. 7, Part II, 1893.
March.	U S. Fish Commission, Washington, D. C.—Report for 1888. Bulletin, Vol X, 1890.
	Edward Gilpin, Esq., Halifax.—Quarterly Journal Geological Society of London, 1893
	Academy of Natural Sciences, Philadelphia.—Proceedings, 1892-1893.

DONATIONS TO THE LIBRARY — (*Continued.*)

DATE.	DONOR'S NAME AND DESCRIPTION OF BOOK.
1893. *March.*	BELFAST NATURALISTS' FIELD CLUB, Belfast, Ireland.—Annual Report and Proceedings, 1892.
	DIRECTOR GEOLOGICAL SURVEY OF CANADA, Ottawa.—Contributions to Canadian Palæontology, Vol. I., Part IV. Catalogue of Section 1 of Museum of the Survey. Catalogue of Stratigraphical Collection of the Rocks of Canada, 1893. Annual Report, Vol. V., Parts 1 and 2.
April.	BUREAU OF ETHNOLOGY, Washington, D. C.—Bibliography of the Algonquin languages, by James C. Pilling.
May.	NEW YORK MICROSCOPICAL SOCIETY, New York.—Journal, Vol. IX., Nos. 2-4.
	CALIFORNIA ACADEMY OF SCIENCE, San Francisco.—Laying the Corner Stone, 1880. Proceedings, Vols I.-III.
	JOHNS HOPKINS UNIVERSITY, Baltimore, Md.— Circulars, 102-107.
	SOCIÉTÉ SCIENTIFIQUE DU CHILE, Santiago, Chili.—Proceedings, etc. Vols. II. and III.
	SOCIÉTÉ ROYALE MALACOLOGIQUE DE BELGIQUE, Brussels.—Proceedings, 1892.
	SMITHSONIAN INSTITUTION, Washington, D. C.— Circular concerning Hodgkin's Prize Fund. Smithsonian Report, 1890.
	U. S. NATIONAL MUSEUM, Washington. Proceedings, Vol. XIV. Bulletins 39 and 40.
	CORNELL UNIVERSITY, Ithica, N. Y.— Bulletins 48-59. Library Bulletins, Nos. 4-5.
	DIRECTOR MISSOURI BOTANICAL GARDENS, St. Louis, Mo.—First, Second and Third Annual Reports.
	UNIVERSITY OF MICHIGAN, Ann Arbor, Mich.—Morphology of the Carinæ upon the septa of Rugose Corals, by Mary E. Holmes. Peach Yellows, by E. F. Smith, 1888. Latitude of Detroit Observatory, by Ludovic Ester, Ph. D. Organic Contamination of Soils, by J. F. Eastwood, M. A.

DONATIONS TO THE LIBRARY — (*Continued.*)

DATE.	DONOR'S NAME AND DESCRIPTION OF BOOK.
1893. *June.*	CINCINNATI SOCIETY OF NATURAL HISTORY, Cincinnati, O.—Journal, Vol, XVI., Nos. 1–3.
	ROYAL SOCIETY OF CANADA, Ottawa, Ont—Proceedings, Vol X
	LIVERPOOL BIOLOGICAL SOCIETY, Liverpool, G. B,—Proceedings and Transactions, Vols. V. and VI.
	MANCHESTER GEOLOGICAL SOCIETY, Manchester, G. B — Transactions, Vol. XXII.
	GEO U. HAY, M. A., St. John, N. B.—Proceedings and Transactions of the Nova Scotia Institute of Science, Vol. V., Part II.
	DR. JOHN BAXTER, Chatham, N. B.— Miramichi Wild Flowers, by Roderick Mackenzie.
	NOVA SCOTIA INSTITUTE OF SCIENCE, Halifax, N. S.—Proceedings, Vol. I., Part IV. (Second Series).
July.	ESSEX INSTITUTE, Salem, Mass.—Bulletins, Vols. XXIV. and XXV. Memoir of Dr. Henry Wheatland.
	U. S. GEOLOGICAL SURVEY, Washington.— Flora of the Dakota Group. by Lesquereaux (Monograph XVII). Gasteropoda and Cephalopoda of New Jersey (Monograph XVIII.) Geology of Eureka District, Nevada, (Monograph XX.) Atlas of Geology of Eureka District, Nevada. Mineral Resources of the United States, 1891. Bulletins of U. S Survey, Nos. 82–86, 90–06. Eleventh Annual Report, 1889–1890, Parts I. and II.
	U. S. COAST AND GEODETIC SURVEY, Washington.—Report, 1890.
August.	GEOLOGICAL SOCIETY OF LONDON, G. B.—Abstract of Proceedings, 1892-1893. List of Members.
	DIRECTOR ROYAL GARDENS, Kew, G. B —Bulletins, Nos. 76–81, 1893. Appendix I., 1894.
	CONNECTICUT ACADEMY OF ARTS AND SCIENCES, New Haven, Conn.—Transactions, Vols. VIII. and IX.
	CANADIAN RECORD OF SCIENCE, Montreal.—Vol. V.
Sept.	COLORADO SCIENTIFIC SOCIETY, Denver.—Proceedings, 1893. Four Parts.

DONATIONS TO THE LIBRARY—(*Continued.*)

DATE.	DONOR'S NAME AND DESCRIPTION OF BOOK.
1893. *Sept.*	**FROM THE AUTHOR.**—Height of the Bay of Fundy Coast in the Glacial Period, etc., by Robert Chalmers.
	COLONIAL MUSEUM, Wellington, New Zealand.—Manual of New Zealand Coleoptera.
	TRUSTEES AUSTRALIAN MUSEUM, Sidney, New South Wales.—Annual Report for 1892. Hints for the Preservation of Specimens of Natural History. Catalogue of the Australian Hydroid Zoophytes. Guide to the Contents of the Australian Museum. Catalogue of Australian Birds, Parts I.-III. Catalogue of Australian Mammals. Records of the Australian Museum, Vol. II, Nos. 1-5. Catalogue of Marine Shells of Australia and Tasmania, Parts I.-III.
	THE AUTHOR.—Observations on Shell-heaps and Shell-beds, by E. J. Statham, Assoc. Inst. C. E., New South Wales.
Oct	**NEW YORK ACADEMY OF SCIENCES**, New York—Transactions, Vols. X., XI. and XII.
	HAMILTON ASSOCIATION, Hamilton, Ont.—Journal and Proceedings, No. 9.
	CANADIAN INSTITUTE, Toronto.—Fifth Annual Report on Archæology. Transactions, Vol. III., No. 6, Part II.
	ROCHESTER ACADEMY OF SCIENCES, Rochester, N. Y.—Proceedings, Vols. I.-II.
Nov.	**BOSTON NATURAL HISTORY SOCIETY**, Boston.—Proceedings, Vol. XXVI., Part I.
Dec.	**NATURAL HISTORY SOCIETY OF GLASGOW**, Glasgow, G. B.—Proceedings and Transactions, Vol. III., 1889-1892.
	ROYAL ACADEMY OF SCIENCES, Stockholm.—Proceedings, twenty volumes; Bulletins 46-49.
	ENTOMOLOGICAL SOCIETY, London, Ont.—The Canadian Entomologist, 1893. Twenty-fourth Annual Report, 1893.
	MANITOBA HISTORICAL AND SCIENTIFIC SOCIETY, Winnipeg. Transactions, thirty-seven numbers.

APPENDIX B.

SOME EVIDENCES OF A GLACIAL EPOCH.

BY CHARLES R. FISHER.

(Read October 9th, 1894.)

This evening it is purposed to give some account of that comparatively short, but remarkable, recent geological time, known as the Glacial Period, or Great Ice Age. The immediate reason for giving this description is because we have before us a quantity of the material, accumulated by ice action during that period. These specimens were found in England, not in Canada, although in many respects, the northern portion of America is undoubtedly one of the finest fields extant in which to study the phenomena resultant upon Glacial action, and especially is this the case in the vicinity of St. John. Above your Canadian Drift you often find clays of a more or less grey or reddish color, known as the Leda Clay, so called because amongst other marine shells, the Leda Glacialis is found extensively in it. Examples of this clay are to be found along the coast of the Bay Shore, near Fort Howe, in the valley between St. John and Portland, (St. John North) along the Red Head Road, in the Horticultural Grounds at Seely Street, and elsewhere. This clay is undoubtedly of sedimentary origin, and one which accumulated very quickly, probably at the time when the immense amount of glacial ice was re-converted into water. I am not aware that the equivalent of this is found in England, though some of the Eastern Counties' Boulder Clay contains many broken portions of marine shells.

Our President, Dr. Matthew, is such an authority upon all connected with geology in this city and province, that I will not attempt to give any account of the evidences in the immediate vicinity of St. John, which tend to prove that at one time this entire region was covered with ice, perhaps to a depth of from one to two thousand feet. My work in this special field has been very desultory, not so much, I hope, from want of inclination as from absence of opportunity. For many interesting facts in connection with your local formations, I am much indebted to the kindness of my friend Mrs. Bowden.

Ice action has been the formative agent of various deposits. During the Pleistocene age, accumulations were laid down upon the older rocks, without any apparent order, often ending very abruptly, and in a manner which indicates the work of quite a different force from any which built up the more ancient strata. The evidences of this action are found in the Boulder Clays, Tills and Gravels of the early Pleistocene Period. The clay sometimes has one or more layers of sand, peat, or fine clay, sandwiched in, showing either the action of water, or the accumulation of a vegetable deposit. The interlayers must have been caused by an intermittingly warmer climate. The peat deposit shows that a considerable period of warm weather must have intervened, for such an accumulation to accrue, as that found in this particular stratum.

Where sand or gravel is found, it is probably consequent upon the depression of the land to below the point of submergence; this portion becoming subsequently re-elevated and subject to re-glaciation. The great weight and power of the moving ice has in some places crumpled the shales and other rocks over which it passed, in the line of their lamination. The Glacial Clays partake largely after the nearest rocks over which they passed, with regard to color.

The geographical extent of the ice in the northern hemisphere was, roughly speaking, bounded by the 50th degree north latitude in Europe, whilst in America it was bounded by parallel 39. It England it does not seem to have reached further south to any extent, than the north of the Thames Basin. During this time the British Isles were united with the European Continent by a vast ice sheet, the whole of the land surface, both in Europe and America, being then, probably, of considerably greater elevation than at present. South of parallel 50 in Europe, immense glaciers would be produced on the Alps, Carpathians, and Pyrenees. In fact, the present Swiss and Pyrenean glaciers are the pigmy remains of once immeasurably larger ice fields. In Asia we find proofs that far larger glaciers existed in the Himalaya Range than those of the present day, occupying the southern slope even, down to within some 2,500 feet of the sea level. Similar evidences of large glaciers in New Zealand are obtained, whilst traces of proof of former glacial action are found in both Australia and South America.

Geological exploration has, as yet, been confined to so comparatively few regions, that anything like a complete knowledge of the range of ice during the glacial age, has not been attained. One fact should be very clearly borne in mind, that the occupation of a certain area by ice does not necessarily imply that that particular district has a so much lower mean temperature, than other places in the same latitude where no ice exists. Through local causes, the precipitation of moisture in the form of snow is so much greater in some districts than in others, that the supply so far exceeds the melting power of the atmosphere as to cause such an accumulation that a glacier is the result. We know that there are districts where moisture seldom or never falls, in cold, as well as in hot districts. Take Siberia as an instance. If any very large quantity of snow fell over that immense territory, it would become one huge glacier, and be totally uninhabitable. Most certainly would this be the case north of parallel 60; yet at Yakutsk it is possible to live, notwithstanding the fact that the ground is permanently frozen to a depth of 700 feet.

Some geologists consider that there has been a succession of Glacial Ages, ranging from Cambrian Times, onward through the Devonian, New Red Sandstone, Lias, and Cretaceons, to the Pleistocene. The evidences, however, are not definite enough to be considered conclusive; although Sir A. C. Ramsey and other writers, hold the opinion that there are traces of glacial action in some of the deposits of those ages.

The ice age which wrought upon so considrable a portion of the earth's surface, such important and remarkable changes, that often the entire contour was altered, took place at a comparatively recent date. Various causes have been assigned for the lowered temperature of the globe at that time. In many places the land was much higher than now, and high ridges of land would act as condensors of the moisture, causing it to fall as snow, in sufficient quantities for glacier building.

The astronomical deductions made by Herschel, Arago, and later by Croll and others, have been of much value to geologists, by giving them data which shews that a much lower temperature was probable at the time assigned for the Glacial Period. This, at any rate, would be the case in the northern hemisphere. Then we have the suggestions that the warm ocean currents were so deflected from the countries whose climatic rigors they now so much modify, that a great change of temperature would ensue. As an instance :—If the Gulf Stream were to have its course turned, say into the Pacific Ocean through an opening in the Isthmus of Panama, London would have a mean temperature about 40 degrees below the present one.

The prevalence of certain winds might prove another possible factor; though these would probably be the result of a changed temperature, rather than the producer of it.

I have, of course, only touched upon the possible causes which might aid in bringing about the epoch of frigidity; to attempt even to sketch out the different theories, would need much more time than I now have at my disposal.

The particular specimens brought to illustrate the subject of this paper, came from what is known as the Upper Glacial Boulder Drift. They were collected from that deposit during the excavations made for a new railway tunnel, which was being constructed in Bedfordshire, East Mid-England.

The organic remains, of which some 55 species were found, belong almost entirely to the Mesozoic Period, and consist of fossils derived principally from the Lias, Oolitic and Cretaceous Formations. These are in a much more perfect condition than fossils of the Drift usually are. Cephalopoda, especially Ammonites, of which some 20 varieties were collected, were abundant. A piece of wood was found in good preservation; it was probably a portion of some Pilocene Conifer. One specimen of Trigonia Pulchella was unearthed; this bivalve has only before been found in the Upper Lias Clay near Lincoln, some 70 miles north of the tunnel. Quite a heterogeneous collection of rock fragments were gathered, igneous, metamorphic, and sedimentary, with numbers of septaria.

Such a mass of debris has sufficient internal evidence to show that it was not laid down in the ordinary stratified form; either by the action of denudation, or by the aid of the remains of a marine or a terrestrial flora or fauna, as is the case with the rocks of the Laurentian age, leading onward through all the Palaeozoic, Mesozoic, and Tertiary periods, and still upward to the immediate Preglacial age, represented by such beds as that of the Norfolk Forest deposit of East Anglia.

Some of the earliest geologists considered such accumulations to be the result of ice action, in the form of bergs. To this theory there are weighty objections. These are the two most important :—

1st. There is no trace of stratification in the deposit.

2nd. There are no remains of the inhabitants of the sea in which the ice would float when it deposited its gleanings, as all fossil remains belong to clearly defined strata of a much more ancient date; so much so, that we may speak of the Ice Age as belonging to yesterday, by comparison with the deposits from which the fossils were derived, which in that case, might be spoken of as pre-historic. The one exception, is the fossil wood which was found, but this is terrestrial, not marine.

It seems from all the evidence that can be adduced, that the vast accumulations of clay, known as the Upper Glacial Boulder Drift, must have been deposited by the direct action of moving ice upon the land. Today the same force may be seen at work in

Switzerland, the Canadian Rockies, and in other localities. In fact, wherever glaciers exist, some such deposits must be made to a greater or less extent. The moraines of the Swiss glaciers being the modern equivalent of the ancient ice deposits.

Undoubtedly England, at the time of the Glacial Period, was united to Scandinavia, and probably to Ireland also. One immense glacier moved southward, being fed by ice-streams branching out, both east and west, in the manner of river tributaries. You may ask "How is this proved ?"

Why, by the contents of the clay. The Bedfordshire Drift Clay is undoubtedly obtained in a great measure from the Liassic and Oolitic Argillaceous deposits, which lie comparatively near at hand. In fact, both are found in various localities not far distant, the Oxford Clay lying in the immediate neighborhood to the north and north-east. These facts are important, as the number of fossils found in this particular drift, which are characteristic of either the Oolitic or Liassic clays, show that the bulk of the material must have been obtained from these sources.

Those fossils and rocks derived from material lying at a greater distance, are naturally much fewer in number, although some must have been brought a long way, as for example the Trigonia Pulchella, whilst some of the rock fragments would seem to be of Scandinavian origin.

There has been much speculation as to the chronology of the Glacial Period. Sir Charles Lyell and his disciples gave a practically unlimited time to life, as we know it in geology.

More modern geologists, guided in a great measure by astronomers and physicists, have arrived at conclusions strikingly different from those of the older school of writers. Here is the contrast, if figures of such magnitude can be sufficiently grasped to appreciate their import.

500,000,000 years ago the Eozoon would be flourishing, according to Sir Charles Lyell. Of course, it is very possible that you do not accept the evidence as sufficient to show that any organism existed, prior to the reign of the Trilobites. Anyway, that is the age given when the Laurentian rocks were being formed.

Young and Wallace, two more modern mathematical geologists, give about 30,000,000 years only, as the time of the "Dawn of Life."

Dana, in his geology, gives this proportional ratio : Palaeozoic, 22; Mesozoic, 6; Tertiary, (together with the Post-Tertiary) 2. From this you will gather that the whole of the deposits ranging from the Lower Eocene to the Pliocene, onward through the Pleistocene to the present time, is only 1-15 of the geological life period. Some authorities give a much less proportionate time value than this even, for the Kainozoic Age. Out of this time, only a small portion can be taken for the Glacial Period, occurring, as it does, after all the great deposits of the Tertiary Age were laid down. Prestwich gives about 25,000 years, as the time for the existence of the Age of Ice.

Next arises the question: How much time has elapsed since the close of the Glacial Epoch? From cumulative evidence a fairly near date can be attained.

The Niagara Falls form, perhaps, the best geological clock in existence, for the purpose of giving the approximate date when this period ended. It took years to work out a satisfactory result, and such men as Sir Charles Lyell, James Hall, and Woodward all aided in solving the problem. It is a very well authenticated fact that the river Niagara is of post-glacial date, as is also Lake Erie, and a large number of the Canadian lakes. Lake Ontario was probably pre-glacial, the Grand River and its tributaries being the means by which the whole of the valley which is now Lake Erie was drained. This river course was completely diverted by ice-action, as be-for the ice age, it entered Lake Ontario at its western extremity at the point where Hamilton now stands.

The calculations as to the length of time since the Glacial Period, are based upon the wearing away of the rock at the Falls of Niagara. The yearly loss of rock by denudation is, roughly speaking, some three or four feet, or even more, as it does not wear evenly, hence its horseshoe form. Take this length and divide into the length of the gorge, and we have a quotient giving from 8,000 to 10,000 years as the age of the river, in other words, as the river is an outcome of the Ice Age, it must be that length of time since the glaciers disappeared from the Niagara district. Undoubtedly we must assume in this case that the same continuity of the volume of water has existed since the Glacial Age.

In the upper part of the Mississippi River is another post-glacial gorge, which forms a valuable indicator as to the time of the Glacial Age. The results here about coincide with those arrived at with regard to Niagara. Other similar cases of denudation give approximately the same results.

The silting up of lakes, whose beds were formed by the agency of ice, show that the Glacial Era could not have been much more remote.

Take your own lakes near St. John, which are all of glacial origin. They are small, and receive a quantity of mineral and organic matter, brought down from the hills by the various streams, and deposited in them, by which means they gradually become filled up. Both Lily and Ashburn lakes have already become nearly filled with silt, in their shallower portions. In a comparatively short time, geologically speaking, both will become swamps, while only a little while afterwards they will be flat grass-land, just as the old rifle-range land now is. That ground was undoubtedly a lake at one time, but became filled up with mineral and organic matter, brought down by the streams from the hills around.

You may ask, "What has this to do with the Glacial Age?" Well, simply this : A computation of the amount of silt there is in the lake, before the hard rock-bed is reached, will give the age of the lake, if the average yearly deposit can be obtained. Calculations based upon such data, approach very nearly in results to those deduced from the erosion of rivers.

It is a moot point amongst geologists whether the age we are now speaking of, was really a time when whole continents were under glacial ice, or whether local climatic influences, coupled with changes of land elevation, would be sufficient to produce this phenomenon. Further, Sir William Dawson has shown that a species of Drift Deposit is being accumulated at the present time in some of the openings of the Canadian Coast, this deposit being formed by the agency of floating ice, in the shape of either bergs or drift-ice. Moreover, the rocks are often much striated. It will be well to remember the fact here, that an iceberg has only about an eighth of its entire mass above the water, the rest being submerged. You can imagine at what a depth some would be in the water, when I mention that I have, myself, seen icebergs some 200 feet high, in and near the Straits of Belleisle. So soon as such a mass of ice gets into comparatively shallow water even, it would run aground, and be swayed about by either the wind or current, in some particular direction, when any stones sticking underneath would be scraped across the sea-floor, by which means they would become striated. Notwithstanding the proofs that in particular instances floating ice may lay down Drift Beds, the consensus of opinion shows that such a deposit as the one particularly described tonight, must have been laid down by glacial action, and for the reasons already mentioned, but which it might be well now to recapitulate.

1st. The formation is completely devoid of stratification.

2nd. The striated stones are very often elongated in shape, showing that they were worn by being pushed along by some solid force.

3rd. The character of the whole of the contents of the clay—both organic and inorganic, point to the fact that some land force must have been at work, to glean such a heterogeneous mass of debris together.

4th. The manner in which the accumulation was laid down, shows a difference in the method employd, from that used to produce the sedimentary deposits.

5th. No marine life remains are found in the clay, of the age in which it was formed.

6th. Similar deposits are now actually in process of formation in some parts of the world, being laid down by Glacial Agency.

In conclusion, it may be remarked that it is still a debatable question, as to whether man's existence was coeval with the Glacial Period. It probably depends upon what is meant by coeval.

If it means with the later ice age, which occurred after the warm Interglacial Period, then, perhaps, the query may be answered in the affirmative, as considerable evidence has been collected which tends to show that man was in existence then, but no trace of his remains were found in the Bedforshire Drift. The Cave and other deposits contain evidences, such as chipped flints and stones, which seem to indicate that he may have retreated before the advancing ice which produced the Upper Boulder Clay.

If man's advent did not occur until after the drift was deposited, yet the men who chipped palaeolithic stones or polished neolithic flints must have lived at a period very remote from us, if we gage the time of their existence simply by the measure of historic chronology.

* * *

Natural History Society of New Brunswick.

APPENDIX C.

THE MOUNTAIN SYSTEMS OF AMERICA.

A COMPARATIVE STUDY.

SYNOPSIS OF A PAPER READ BEFORE THE SOCIETY
JANUARY 2ND, 1895,

BY LORING W. BAILEY, M.A., PH D.

After referring briefly to the part which mountains play as elements in the earth's physiography (helping to determine climatic differences, the distribution of rain fall, the size and flow of rivers, the limitation of floral and faunal areas) beside directly affecting human affairs by their influence on national characteristics, on religion, poetry and art, on wars and commerce, and finally as being the chief source of mineral wealth, Dr. Bailey went on to give a comparative description of the three great mountain systems of America: the Laurentian, the Appalachian and the Cordilleran, or Rocky Mountain, systems.

Of these the Laurentian was described as being at the same time the oldest and the lowest, including the belt of broken land which, in the form of a gigantic V, stretches from Labrador to Ontario, and thence to the Arctic Sea, enclosing between its arms the depression of Hudson's Bay. It thus forms the backbone of this Canada of ours, and is especially interesting as being one of the earliest of the centres from which the continent began to grow, and as having been probably continuously above the ocean from the earliest times. Thus, through unnumbered ages, it has been the theatre of atmospheric denudation, and what we now see of it is but the remnant of what it once was. Indeed, a close study of its denuded folds and of the great faults or dislocations by which it has been affected, alike prove the extent of its degradation, and lead us to believe that originally the system may well have borne comparison with the loftiest of existing chains.

The Appalachian or Alleghany system was next referred to as stretching from Gaspe to the Carolinas, and forming the eastern wall of the continent. Though hardly so long as the Laurentian system, it embraces a far greater number of subordinate chains (such as the Shickshocks of Gaspe, the Notre Dame range of Quebec, the Green and White Mts. of New England, the Highlands of New York, the Blue Ridge of Virginia, etc.) and includes some much higher summits, such as Mt. Washington in New Hampshire. It is also more complex in structure, involving the results of many mountain-making movements, but not completing its history until after the deposition of the coal-beds, these (in Pennsylvania) being included in the folds and faults by which the region was raised into mountain form. Since that time its history, like that of the Laurentian, has been one of waste and removal.

Lastly we have the great Rocky Mountain system, better known as the Cordilleran system, for the Rockies proper form only one element in the system as a whole, the latter properly embracing all the high land lying between the region of the Great Plains and the Pacific coast. This region, nearly 1,000 miles in width, was somewhat minutely described as seen, first along the Union Pacific R. R., or 40th parallel, and secondly along the line of the C. P. R. In each case it was shown to embrace a number of approximately parallel chains, including basins or plateaus between, and each exhibiting features peculiar to itself. Thus, on the line of the 40th parallel, the eastern ranges, constituting the Rockies proper, were described as rising abruptly from the region of the Plains to heights of 10,000 to 14,000 feet; while upon their western side they look down, with almost equal abruptness, upon the Green River and Colorado Basins, the two being separated by the east and west chain of the Uintahs, and together making up what, from a geological point of view, has been well styled the Plateau Province. This name is suggested by the fact that everywhere around the borders of this relatively low and flat tract are found great masses of horizontal strata, arranged in steps or plateau, one above another, the descent from one to the other being often precipitous and hundreds or even thousands of feet in amount; while near the edge of the successive terraces are numerous outlying masses or buttes, which were evidently at one time continuous with the adjacent terraces, but have since been separated as the result of wear and removal. It was then shown that a similar removal of rock, to a thickness of nearly *two miles*, had taken place over an area of at least 100,000 square miles, the terraces or plateaus, representing successive formations of different ages and degrees of hardness, being only the remnants of what once covered the whole region. Further, in the centre of the basin, this process of erosion was described as finding still grander illustration in the great canon of the Colorado River, a profound trench cut by the river across the whole Plateau Province, and having a vertical depth, with nearly precipitous sides, from 2,000 to 6,000 feet. This canon was described as one of the greatest of nature's wonders and its history fully detailed, while increased interest was given to the descriptions by the exhibition of numerous plates and a large number of photographs taken by the various exploring expeditions sent out by the U. S. government. On the west the Plateau Province, embracing a large part of the State of Colorado, is again abruptly met and walled in by the lofty range of the Wahsatch Mts., separating the Colorado Basin from what, ever since Fremont's time, has been known as the "Great Basin." This is the flat, treeless and almost utterly desert tract, including the region around Great Salt Lake, which at one time proved such a barrier to the tide of westward emigration, and which is still uninhabitable except where, as at Salt Lake City, fertility has been partly restored by artificial irrigation. The waters of Great Salt Lake are so dense that the human body is sustained on them without exertion and becomes, after bathing, encrusted with salt. Several rivers, such as the Humboldt, Carson and Truckee, traverse portions of the desert, being fed by melting snows from the mountains, but, unlike most streams, become smaller as we recede from their sources and are finally swallowed up in "sinks." So lakes, many square miles in surface, sometimes appear after heavy rain fall, and vanish a few hours after the latter has ceased.

This great desert is 100 miles wide, and on the west is again abruptly terminated by the lofty snow-clad range of the Sierra Nevadas, 500 miles distant from the Rockies, and rivalling the latter in elevation, as they exceed them in the grandeur and diversity of their scenery. Their greatest altitude is upon the eastern side, where they form an abrupt wall facing the Great Basin, and rise to a height of 14,000 feet. But to the west the slope is more gradual, descending slowly to the low land of California, which, however, is again separated from the Pacific by the chain of the Coast and Cascade ranges.

From the description of the physical features of the Cordilleran system the lecturer passed on to sketch its geological history, which is truly wonderful.

It was first pointed out that, alike in the Rockies, the Wahsatch and the Sierra Nevada ranges the core of the mountains is composed of the most ancient or Archæan rocks, and that these, prior to Cambrian times, formed a sort of semi-continent in the far west, the land being mostly of a mountainous character, and involving peaks and precipices miles in height, which, in magnitude, are now only rivalled by the topography of the moon.

In the Palæozoic ages which succeeded the Archæan, this lofty western land mass would seem to have slowly subsided until about 30,000 feet of sedimentary beds, of marine origin, had been deposited upon it, burying all but its highest summits. The immensely long period of time required for such deposition seems to have been unattended with any greater physical disturbances, but from its close and onward the evidences of such disturbances are frequent and upon a scale of unequalled magnitude Thus, at the close of the Carboniferous period, or end of the Palœozoic ages, we find a movement occurring by which western Nevada, with portions of Oregon, previously dry, sink far below the sea level, while, simultaneously, eastern Nevada, western Utah and Idaho rise above it. The movements occurred along lines of fault, one of which, now forming the eastern wall of the Sierras, is 300 miles long, and marks a dislocation by which the Nevada country has been relatively dropped 3,000 to 10,000 feet.

The next great movement was at the close of the Jurassic era, and after 20,000 feet more of sedimentary beds had been deposited over the areas which were in a position to receive them. Again we find a change in the disposition of land and water. The Oregon-Nevada basin now disappears by the rising of its bed, and simultaneously the Pacific coast subsided beneath the waves. So in the early Cretaceous or chalk era there was a renewal of disturbance, in this instance so violent that over an area embracing thousands of square miles the rocks were so shaken and shattered that the fragments produced do not on an average exceed a hen's egg in size. The Coast and Cascade ranges also date their beginnings from this time.

Still later, at the close of the Cretaceous, came other movements resulting in the partial subsidence of the Coast Range, reducing it to a chain of islands, while east of the Wahsatch and thence to the Rockies the land rose from 30,000 to 40,000 feet, thus completing the "Pacific slope," at the same time that to the eastward of the Rockies the region of the Great Plains became for the first time dry, and, by the disappearance of the old Inter-American ocean, eastern and western America became united into one great continental land mass.

From this time onward we find no further depression of the west below the sea level. There were, however, frequent movements and a continuation of the old system of dislocation, further breaking up the surface, while in the hollows thus formed were produced a series of great inland lakes, bordered by extensive forests, whose shades gave shelter to vast numbers of gigantic mammals and other forms of life. But in time this condtion also passed away. The lakes were drained off as the mountains rose—aridity followed upon excessive humidity—the rivers dried up or became shrunken to narrow defiles, like that of the Colorado, and indescribable deserts began to take the place of what before had been a region of universal verdure. At the same time, along the lines of fracture, great floods of lava welled up from below, to spread in molten torrents over vast areas, and helping still further to make uninhabitable the already sterile wastes.

But, with this disappearance of all that would tend to make the surface suitable for tillage and for man's habitation, came also the storing of the fissured rocks with mineral veins, making the region the most productive mineral region in the world. For, from the same region, up to the year 1880, there had been removed, in gold, lead, silver and quicksilver, a total product of not less than 2,000 *millions* of dollars. The lead and silver are chiefly found along the line of the old Wahsatch fault—a fault by which the western half of the chain had been dropped some 40,000 feet, while the gold belt of California lies along the western flank of the Sierra Nevada, where a similar displacement of many thousands of feet has been shown to have taken place. Lastly, the great quicksilver deposits, without which the gold could hardly have been discovered, lie nearer to the coast, and undoubtedly owe their origin to the powerful movements and accompanying igneous phenomena by which the latter had been affected.

The lecture closed with some further comparisons in the character of the movements distinguishing the three great mountain systems of the continent, and the belief was expressed that, as regards the Rocky Mountain system, these movements were still in progress, and that volcanic outbursts, upon an extensive scale, might at any moment renew in that region the events which at no distant period marked its history.

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M. H. Perley

MOSES H. PERLEY

As a memento of the earlier years of this Society a vignette of the late Moses H. Perley is inserted in this Bulletin. Mr. Perley was one of its founders, and for several years the first Vice-President. He took an active interest in its welfare, read papers at its meetings, and gave several contributions to its museum,—but an untimely death deprived the Society of his valuable services, not many years after its institution.

Mr. Perley wrote reports on the Fisheries of New Brunswick, addressed to the legislature of New Brunswick, 1849–51, which for many years remained the authority for information on this important subject, and is quoted and referred to in Dr. Cox's article on the Fishes of New Brunswick issued in this Bulletin.

Besides his reports on the fisheries, Mr. Perley also wrote a very useful little "Hand-Book of Information for Emigrants to New Brunswick," which contained an account of the climate, forests, fisheries, geology and mineral resources, topography, and other useful information. This was published in London (1857) in aid of immigration, for which he was agent, or officer, at that time.

Known as an authority on British North American fisheries, Mr. Perley was appointed British commissioner for settling the boundary along the Atlantic coast of British America within which only British subjects have the right to fish. It was while engaged on the work of this commission that Mr. Perley died suddenly at Forteau, on the coast of Labrador, in August, 1862.

Mr. Perley was a native of New Brunswick, born at Maugerville, 31st December, 1804. He was educated at St. John, N. B., called to the bar in 1830, and practiced law for some years in that city. Of his family only one, Henry F. Perley, C. E., of Ottawa, now survives.

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ERRATA.

Page	36,	line	21,	for	“re-cchoing,”	read,	re-echoing.
“	37	“	20,	“	“*Leuciseus,*”	“	*Leuciscus.*
“	38	“	4,	“	“*auguillaris,*”	“	*anguillaris.*
“	38	“	25,	“	“*Auguilla,*”	“	*Anguilla.*
“	50	“	16,	“	“Uranidea,”	“	Uranideæ.
“	51	“	15,	“	“*quadrilaterials,*”	“	*quadrilateralis.*
“	53	“	14,	“	“*longirostus,*”	“	*longirostris.*
“	64	“	4,	“	**“oxyrinchus,”**	“	**oxyrhynchus.**
“	71	“	5,	“	“head-quarters,”	“	head-waters.
“	94	“	12,	“	“this new knowledge,”	read,	new knowledge of this kind.
“	88	“	17,	“	“archology,”	read,	archæology.

to locomotion. Its relation to other topics of the series is

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* In the first paper (p. 4, footnote) I said this term had not been before used, so far as I was aware. The editors of the *Botanical Gazette* (XX. p. 38) have called my attention to the fact that the word occurs in the Century Dictionary, and Mr. F. L. Sargent of Cambridge reminds me that it is used by Lubbock in the title of a paper of his upon Seeds and Seedlings, published in the Trans. Linn. Society for 1886. It would have been strange if so fitting a word had not before found use.

BULLETIN
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AN OUTLINE OF PHYTOBIOLOGY.

WITH SPECIAL REFERENCE TO THE STUDY OF ITS PROBLEMS BY LOCAL BOTANISTS AND SUGGESTIONS FOR A BIOLOGICAL SURVEY OF ACADIAN PLANTS.

BY W. F. GANONG, PH. D.

Read June 4, 1895.

SECOND PAPER.

ADAPTATIONS OF PLANTS TO LOCOMOTION.

In the first paper of this series, Phytobiology * was defined, its relations to other departments of botany were explained and divisions were proposed for its treatment. In taking up these divisions it is not needful to hold to the order there given; and I have decided to treat first the one which I think will prove of the greatest use and interest to our botanists. This is the adaptations of plants to locomotion. Its relation to other topics of the series is

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* In the first paper (p. 4, footnote) I said this term had not been before used, so far as I was aware. The editors of the *Botanical Gazette* (XX. p. 38) have called my attention to the fact that the word occurs in the Century Dictionary, and Mr. F. L. Sargent of Cambridge reminds me that it is used by Lubbock in the title of a paper of his upon Seeds and Seedlings, published in the Trans. Linn. Society for 1886. It would have been strange if so fitting a word had not before found use.

shown in the following synopsis, which, as already emphasized, outlines a convenient rather than a logical treatment of the entire subject.

Introduction and Classification. *Published in Bulletin No. XII.*
A. Adaptations of Plants to Inorganic Nature: *to be prepared.*
B. Adaptations of Plants to other Organic Beings: *to be prepared.*
C. Adaptations of Plants to Reproduction: *in preparation.*
D. Adaptations of Plants to Locomotion: *the present paper.*
E. The Biological Groups of Plants: *in preparation.*
F. The Climatic Groups of Plants: *to be prepared.*
G. A Summary of the Biological Characteristics of the Vegetation of Acadia: *to be prepared.**

I. THE GENERAL SUBJECT.

There are five great primal necessities common to all living beings: nutrition, growth, protection, locomotion, reproduction. Of these, locomotion, our present subject, is not less important than the others, while it exceeds them all in the elaboration of adaptations to bring the plant into relation with its environment. Viewing locomotion in a broad way, we find that it must be provided for in both animals and plants for the following reasons:

1. To prevent overcrowding, so as to allow each individual enough space for its development.
2. To effect the union of the sexes.

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* This is the original outline proposed in the first paper, to which, however, it is not necessary closely to adhere. A more logical arrangement, and one which I shall probably adopt, is as follows: Adaptations of Plants to *A. Nutrition; B. Growth; C. Protection; D. Locomotion; E. Reproduction. F. Biological Groups; G. History and Distribution; H. Philosophical Summary; I. Summary of Biological Characteristics of Acadian Flora.*

I may here also emphasize such distinction as exists between Physiology and Biology, though they merge together at many points. Physiology has to do with the chemistry and physics of the operations, chiefly internal, of living beings, while Biology treats of their adaptations to the external world.

In addition it secures to them the following advantages, and these are of vast importance in the struggle for existence.

3. To give the new individuals opportunity to develop under environment somewhat different from that of the parents, thus promoting vigor and variability, the two qualities upon which progressive development in evolution depends.

4. To mix individuals derived from different environments so that cross-fertilization may occur between plants of different stock, thus promoting in the offspring the advantageous vigor and variability.

5. To allow a race to move to new localities as it exhausts certain essentials in the old.

For the animal world should be added to these, to escape from enemies, a condition which in plants must be otherwise worked out.

Among animals, all of these advantages are secured to them by the power of independent movement which they nearly all possess; but among plants, which lack this power, the same end must be attained in a totally different way. One of the most fundamental differences between animals and plants consists in this, that plants being nourished by inorganic materials which are brought to them by the movements of the atmosphere, or of water in the soil, have not needed to move for the greatest of all necessities, that of food; their cells have accordingly built up the firm non-contractile cellulose and its derivatives, a supporting skeleton capable of great size and strength, but not of motion; while animals, living upon other organized beings, which they must go in search or pursuit of, have formed a contractile substance, muscular fibre, and the presence of this gives a muscular system and the possibility of locomotion to even the largest animals. Yet that plants do in some way secure locomotion is very clear. One has only to recall the rapid spread and great range of weeds, or the world-wide distribution of many water-plants. Indeed, taken as a whole, it is probable that the aggregate locomotive accomplishments of plants are fully equal to those of animals, even though they are less rapid, less striking, less well-known. How then, it is now our task to inquire, does it come to pass that plants, themselves incapable of independent locomotion, yet so perfectly secure it? The answer is in essence this: It is secured to them *by the separation of small parts of their substance capable of reproduction, and the adjustment on these of structures adapted to utilize the various locomotive forces of nature.* The end is thus as certainly attained as among animals; there is but a difference in the method. Instead of the entire organisms moving, small reproductive parts move; instead of by internal powers it is by utilization of external agencies which can move.

Of the five needs for locomotion above-mentioned, the third, fourth and fifth can be secured along with the first, and indeed in the animal world all five are ensured by the power of independent movement; but among the higher plants, the first and second require distinct methods. In the first case, that of simple scattering to prevent overcrowding, the problem is simply to remove to a considerable distance, and preferably to favorable situations, reproductive parts of a plant; in the second case, that of effecting union of the sexes, *i. e.*, union of pollen and ovule, the problem is more difficult, for not only must one of the uniting elements be removed to a distance, but it is to be deposited in a special position, *i. e.*, the male is not simply to be carried away from its producing structure, the anther, but it is to be deposited on a special part of the female organ, the stigma, and the problem is made the more difficult by the fact that cross-fertilization being absolutely more advantageous than self-fertilization in nature in the struggle for existence, it has to be provided that the carrying of the pollen shall .be to the stigma of another plant. Hence come the adaptations to cross-fertilization, resulting in the formation of the flower, with its colors, odor, nectar and varied forms, the whole affording us the most splendid example of adaptation to be found in the vegetable kingdom. This division of locomotion is, however, so large and important that although it belongs logically in the present paper it must receive separate treatment, and it will be considered in a future paper of this series along with "adaptations to reproduction;" at present we devote our attention to locomotion of plants as scattering them through space.

Let us understand clearly the mechanical problem involved. A piece of matter endowed with life, and having size and weight, must be moved through a considerable space in such a manner as not to injure it. Only a very limited movement can be effected by the plant itself, so that in the vast majority of instances the movement must be effected by outside agencies. How, then, can the plant effect movement, and what are the forces in nature outside of the organism capable of moving ponderable matter?

The former can occur through

I. Independent animal-like movement.
II. Extension away of parts by growth.
III. Locomotion by movements of ripening tissues.

The latter are

IV. Currents of air.
V. Currents of water.
VI. Movement of animals.
VII. Gravitation.

Of these, gravitation is of little importance since it can only effect movement downwards and not laterally. As to the others, aside from the first which uses simply the contractile power of protoplasm, some mechanical arrangements must be provided so that the part may be brought into contact with the moving power, and be moved by it. This is in brief accomplished by the formation of new individuals at the ends of runners, etc., in the second case, by the drying or ripening of tissues under tension and their sudden release in the third, by formation of wings or plumes in the fourth, and of floats in the fifth, and finally by the development of hooks or sticky coats, or of edible fruits enclosing seeds protected from digestion, in the sixth; of course all kinds of combinations and gradations between these methods occur. The principles of these arrangements we must discuss in some detail.

We must consider next what parts of plants can best be locomoted. Excepting in the first and second, where growth and locomotion go on together, it is necessary that the part shall be capable of reproducing the organism that it can hold its life for a time in suspension, that it shall carry nourishment to give it a start in its growth, and that preferably it shall be small and light. In some cases, especially in the lowest cryptogamic water plants, these qualities reside in the entire organism, and these move as a whole, but in the higher land plants there have been developed special structures which combine these qualities; these are in some cases, buds, in others spores, and most important of all, seeds. Buds usually have the disadvantage of not being able long to retain vitality after separation from the parent plant, but seeds can retain their life for much longer periods and during long transportation, and it is in them that we find by far the most perfect arrangements for locomotion. Indeed the seed is what it is mechanically, chiefly because it is the locomotive stage of the plant.

The seed is, in origin, a fertilized ovule. The flower is itself a structure for securing locomotion, the locomotion of the male to the female and all of its parts and colors and odors, etc., are adaptations to this end. Immediately after the act of fertilization all of the accessory parts, calyx, corolla, stamens, style and stigma, become useless, and they either wither and drop off, or else they may be retained and made of use to help form the various structures, which the seed needs in order to take advantage of moving agencies; thus any of them may form wings, plumes, floats, hooks, pulps, etc. In all such cases the seed itself has no disseminating structures of its own — those of the fruit are sufficient. This occurs commonly in few or single-seeded fruits, which are indehiscent and where the entire structure ripens or is carried off. But in fruits containing many seeds, the fruit remains on the plant until all seeds are ripe, and each seed has some arrangement for locomotion by itself.

From a biological point of view it does not matter in the least from what part the disseminating structures are developed, but from the morphological side it is very important to trace the exact structural origin of each peculiarity. It is soon apparent that the same biological end may be attained in the most diverse morphological ways; a wing may be either bract, calyx, wall of ovary, or outgrowth of the seed coat; the pulp of a fruit may be bract, receptacle, calyx, ovary, placenta, hairs or seed-coat, and so on. Any available structure whatever may be expected to be utilized for the formation of a useful feature. What it is which determines what particular morphological part shall be employed in any given case, is usually unknown, but there can be no doubt that in general it is determined by the fundamental principle of least resistance — the most available or the most easily modified structure is led by the adaptive forces along the easiest lines, and the result is the structure as we have it.

It is of course necessary in the study of locomotion as elsewhere in phytobiology, to distinguish that which has been adapted from that which is incidental. All gradations between these occur. Without doubt in very many cases the adapted has originated in the incidental. Thus the presence of a wing on a seed is a case of gradual adaptation to wind-locomotion, and the principle of natural selection explains very well how adaptation may have been perfected. On the other hand the wide locomotion which willows secure by the floating of their brittle and wind-broken twigs is incidental, though it is easy to understand that if it were worth while this mode of locomotion could be improved and perfected, Examples of structure just on the boundaries of the adapted and incidental are found in some of the modes of vegetative locomotion presently to be mentioned.

As in the case of many other natural phenomena, the facts of locomotion have long been known, but it is only in this century that the philosophical significance of the facts has been understood. That seeds are scattered by wind and animals is plain to observation; but to know that plants derive advantage from this, and that the advantage in the keen struggle for life to which they are exposed may explain the perfecting and even the origin of the adaptations to secure the locomotion, this is knowledge which has been gained slowly and has been made possible only by the light thrown upon all organic processes by the principle of evolution.

The classical work on locomotion of plants is Friederich Hildebrand's "Die Verbreitungsmittel der Pflanzen," (The Dissemination-methods of Plants), published in Leipzig, in 1873. This work sums up the subject most admirably and is characterized by philosophical treatment, richness in facts and judicious selection in illustration. No work has yet superseded it, and all students since its appearance have based their studies upon it. I have myself made free use of it in the preparation of this paper. Darwin has much to say on this subject in the "Origin of Species." Since then Hildebrand, Huth, MacLeod, and very many others have worked on the subject. MacLeod has published a most useful bibliography of publications on dissemination from 1873 to 1890 (in Botanish Jaarboek, Ghent, 1891.) Finally, Kerner, in his "Pflanzenleben," (English translation by Oliver,) has given us a most valuable though popular discussion, richly illustrated, and Lubbock presents a good summary in his "Flowers, Fruits and Leaves." The present paper is designed not to describe the facts already so well set forth in these works, but is an attempt to reduce our knowledge of the subject to definite principles which will make more easy an objective knowledge of the subject and guide our local botanists in further studies into the subject.

II. Principles of the Modes of Locomotion of Plants.

I. Independent Animal-Like Movement.

Since plants lack altogether muscular fibre, it is only possible for independent automatic locomotion to occur where the contractile power of the protoplasm itself can be utilized. This occurs only in unicellular or very few-celled organisms, *i. e.*, only in the lowest and smallest plants. Many of the lower algæ produce spores, (called zoospores) which can swim freely through the water by means of cilia or flagellæ, precisely as animals of an equivalent grade do. The Diatoms move by use of protoplasmic filaments, and some filamentous algæ, the Oscillariæ, by vibrating movements of their rod-like structure. Among land plants, some of the slime-moulds, or Myxomycetes, can creep over damp surfaces exactly as the animal amœba does, *i. e.*, by continually causing its very plastic substance to flow in a constant direction. No higher land plants whatever have the power of independent locomotion.

II. Extension Away of Parts by Growth.

In the higher plants, a branching root and stem system prevails, each part of which grows only at or near its tip. By sending out these growing parts laterally and allowing them at a greater or less distance to turn upward and grow into an erect plant, or to send off an erect plant by branching, an effective and rapid though not extensive locomotion can be brought about. The connecting part may subsequently die, leaving them independent. There are several ways in which lateral growing parts may act.

1. Horizontal underground roots and rhizomes, more or less long and slender, may send up new plants (called "suckers") from adventitious and axillary buds respectively. Examples of the former are Blackberry, *Asclepias Cornuti*, etc., and of the latter, *Triticum repens*, *Achillœa millefolium*, and many others. The same method occurs abundantly in water plants. It incidentally brings about the formation of turf, and makes some plants very difficult to exterminate, and hence they become "weeds."

2. Offsets and runners above ground form new plants at their tips. The Houseleeks *(Sedum)*, *Lobelia cardinalis*, show the former, and the Strawberry, *Potentilla anserina*, etc., the latter method.

3. Slender stems or branches bend over and take root and produce a new plant at their tips forming "stolons;" such are some species of Rubus.

4. Plants in which the main stem creeps horizontally either above or below ground and in which the old parts die behind as the new advance, attain locomotion by the very act of growth. Ferns and Solomon's Seal are examples. Such plants may branch and after a time by the death of the old connecting parts may give rise to several independent individuals. In the tropics there are epiphytic plants which creep along the stems of trees and have this same habit, such as *Pothos.*

5. Bulbs may be drawn away from their producing plants by the shortening of lateral roots. Many bulb plants which form small side bulbs, send out from them, horizontally, slender roots. Later, the connection of bulb with the old plant is severed, the roots shorten and draw away bulb from plant. *Ornithogalum nutans* and *Tulipa sylvestris* are examples.

6. An inclined stem may develop aerial roots called "stilt roots," by which it is nourished and supported several feet from the ground: in time the old stem and roots die behind and the plant continuing to grow and to produce new roots, the plant thus secures movement from place to place. None of our plants do this but it occurs in many of those of the tropics. A modification of this habit, in that the old parts continue to grow, there is profuse branching, and the roots thicken up to stems, gives us the habit of the banyan.

In addition to the formation of new plants at the ends of laterally extended parts, many forms of separable buds, bulblets, branches, etc., are formed directly upon the plant, but these all are adapted to being scattered by some of the moving agencies, wind, water, etc., and they will be considered under those topics.

III. Locomotion by Movements of Ripening Tissues.

Although the skeleton built up by plants out of cellulose and its derivatives is not contractile, it nevertheless is capable of producing locomotive movement if ripenened in special ways. By this means either slow, creeping movements or very rapid projection may result, though the resulting locomotion can never be great. It is clear that for projection, seeds, not buds, nor even very light spores are adapted, and the most efficient seeds for projection are nearly or quite spherical, smooth, hard and rather heavy. The various modes are as follows:

1. Cell walls may become strongly hygroscopic, swelling and shrinking and altering shape as moisture is absorbed and given up, just as a board warps, and in small pieces the movement may be rapid. Sometimes slender hyroscopic arms are attached to spores and move them from the capsule or even farther, as in the spores of *Equisetum.* In *Vanda teres,* a tropical orchid, hygroscopic hairs force out the seeds to be carried off by the wind. There are even a few seeds and fruits which are pushed along the ground by the hygroscopic twistings of some of their hairs, certain hooks which point backward allowing only of a forward motion. Such are some species of *Trifolium.* In *Avena sterilis,* the "living oat," this movement is very perfect and may be somewhat sudden. Related movements assist in burying seeds as will presently be considered, and in closing fruits when weather is unfavorable, and opening them when favorable.

2. Certain bands of tissue may ripen under restraint in a state of tension so that finally, and more or less connected with drying-up or hygroscopicity, when the restraint is released or overcome, the parts spring suddenly to a new position and hurl out the seeds, sometimes to a distance of many feet. This may come about by the formation of special elastic unicellular "elaters" which force out the spores from the capsule in many mosses. Or the sides of the carpels may come to press harder and

harder upon the smooth seeds between them until these are suddenly and swiftly ejected as one shoots a bean or nut from between the fingers, as in some stemmed violets. Or the styles may ripen on an elongated receptacle forming springs to hurl away ovary or seeds as in the genus *Geranium*. Or the carpels under spiral tension burst all apart from one another as in many Euphorbiaceæ, in some cases as the castor bean, or better the West Indian "sand box," bursting with a loud report and hurling the seed many feet. Or two-valved pods may split suddenly by the independent rolling up of the two valves, as in some vetches and lupines.

3. Soft fruits may become strongly turgescent, *i. e.*, gorged with water in their inner and dry on their outer parts, until finally they explode at the weakest point and shoot out the seed. This happens in fruits with valves, in which case the latter usually suddenly curl up and throw off the seed, as in *Impatiens*, and many Cruciferæ, or the entire pulpy interior may become turgescent under a firm skin, as in some Cucurbitaceæ. In the "squirting cucumber" of the Levant, pulp and seeds are shot through the opening left where the fruit drops from the stalk, while in *Cyclanthera* it bursts along the sutures.

The power of ripening tissues to produce movement is also used to assist seeds in self-planting, and to aid locomotion by the production of tumble-weeds and to form elastic stalks, all presently to be described.

IV. Locomotion by Utilization of Air Currents.

Of all of the locomotive forces of Nature, air currents are the most universally prevalent and easily utilizable. They are of all grades, from the barely perceptible up-and-down convection currents of still warm days to great gales. To effect by them a movement from place to place, it is simply necessary to develop about the seed structures which will spread as great a surface as possible in proportion to weight. This principle is worked out in various ways as follows:

1. Various more or less light vegetative parts capable of reproduction may be blown from a plant by strong winds: such as leaves in begonias and Bryophyllum, joints of stem as in some cactuses, rosette branches in some sedums, small bulblets in some lillies and ferns, even brittle twigs as in willows, though here doubtless the mode of locomotion is rather incidental than developed.

2. Plants or their parts develop large surfaces and are rolled by the wind along the ground. Entire plants curling their branches upward assume a ball shape, loosen their hold on the soil by rotting or breaking or pulling out of the roots and are blown along, rolling over the ground as "tumble weeds," either scattering their seeds as they roll, or more commonly coming to rest and scattering them, when rain gives proper conditions for their growth. Such plants are rare or wanting in wooded regions, but are abundant on open plains especially those with a long dry season. The "Russian thistle," now doing so much damage in the west, is a good tumble-weed, and *Plantago cretica* of Europe, and possibly the "Resurrection Plant," of the south-west is another. The classical case of the "Rose of Jericho," of Palestine, must be given up as it only rarely and accidently becomes uprooted. It is frequently the case that fruit clusters become tumble-weeds, as in some Umbelliferæ, and in some clovers where the sterile stalks of a head become feathered and this gives a surface for the wind to roll along the fertile ones. Sometimes the fruit curls up to a helix with very flat spirals, and is thus rolled along as in some species of *Medicago*, and there is perhaps an approach to this structure in the pods of the honey locusts; or the single fruit may become very large and loose in texture, or the pod very flat and thin, and be carried far from the plant by the wind and then rolled along. It is probable that some seeds, as those of the birches, are adapted to being blown along the surface of the snow.

3. By extreme minuteness a relatively large surface proportional to bulk can be attained without special appendages, for as a sphere diminishes in size its bulk diminishes relatively more rapidly than its surface. Thus very minute spores can swim in the air like dust, as do these of moulds, etc., and those of mosses, ferns, etc., can easily be blown to great distances. Amongst Phanerogams the presence of a several-celled embryo makes it difficult to reduce them to so small a size, but in certain orchids they are very minute. Plenty of plants bear tiny seeds, which, thrown from their capsules by strong wind-gusts, are by them carried considerable distances, as will be mentioned below. Sometimes as in orchids, the seeds are surrounded by a sort of loose sac containing air which makes them much lighter.

4. Seeds or fruits of trees develop wings which either act as sails or else as parachutes, causing the slow fall and hence wider lateral carrying by the wind. In all cases the centre of gravity of the seed is so adjusted that the fall is as slow as possible. In the simplest cases, the seed itself becomes very flat and thin, as in some species of Iris; in addition there may be the development of a wing around the edge. The wings may be formed from a bract as in linden, grasses, *Carpinus*; from the ovary as in elm, maple, ash; from the corolla in rare cases; from the calyx as in scabiosa; from the seed-coat as in catalpa, pines and spruces.

As noted, wings are almost confined to tree seeds, since the height of the tree gives them a good start with the winds, which would not be true in herbs or low plants.

5. Upon herbs and low growing woody plants, where the seeds need not only to be carried laterally but also raised in the air, plumes or tufts of hairs are developed. Frequently these are such that the entire mass forms a light ball, but more often the plumes are at one end, sometimes connected with the seed by a stalk, as in the dandelion, in which case the whole structure keeps an upright position and the wind may carry it for immense distances. Indeed where the plume spreads out horizontally and the seed hangs on a stalk beneath to keep the whole

balanced, even the light convection currents of a hot summer day may raise them up to considerable heights, whence they may be widely spread. These light plumes form the most efficient of all the modes of locomotion. Most weeds owe a part at least of their success to them, and the family Compositæ owes its great predominance in part to the fact that the collection of the flowers into heads and their protection by the involucre has set free the calyx to form the pappus, giving to each single seed one of the most effective of known disseminating structures.

The plume or hairs may be formed of the sterile flower stalks of a cluster, as in the "smoke bush;" from the fruit stalk as in *Typha;* from the calyx as in compositæ, from the style as in *Geum* and *Clematis*; from the wall of the ovary; from the seed-coats as in cotton and milkweeds; from the funiculus as in willows. In rare cases the filro-vascular forms after decay of the soft tissue a light frame easily blown away.

6. The stalks of seed-pods may ripen elastically so that when gusts of wind shake the pods, the seeds are hurled out especially by the recoil. In these cases, the seeds, which are small and smooth, are early loosened in the pods and the latter open not at the bottom or along the sides but at the top, and in such a way that they form smooth grooves along which the seeds as they are hurled out are guided at such an angle that they are sent to the greatest distance. This is one of the commonest modes of locomotion among herbs, and occurs according to Hildebrand in *Scrophulariaceæ*, *Campanulaceæ*, *Papaveraceæ*, *Primulaceæ*, *Caryophyllaceæ*. It may be well seen in the common poppies. This shaking of the stalks and their sudden recoil may be brought about also by passing animals, and probably the bladdery pods of some plants as *Staphyllea*, etc., may assist this mode of locomotion by giving the wind a larger surface to work against.

The wind may also assist in locomotion by driving floating seeds over lakes or the ocean either by blowing directly against them, or by creating surface currents which carry them.

V. Locomotion by Water Currents.

To utilize the movement of water currents for locomotion, it is needful that the parts to be scattered shall float, and be able to resist decay for a considerable time, but finally sink to the bottom. The floating is usually effected by the development of air-holding tissue. Water currents are of three kinds: 1. Those caused by falling rain, both as it falls and as it runs along the ground; 2. Those caused by wind on non-flowing water; 3. Those of flowing water. Of these the first and second are not of much importance, and there is probably more of the incidental than of adaptation in the locomotion they effect; the third is more efficient.

The various types are as follows:

1. Seeds or fruits of wind-scattered land-plants are very light, and when accidently they fall in water, they float, and may be carried far. But they rarely reach conditions favorable to germination and hence this incidental method is of little value. It may, however, explain the reported fact that some heavy-nut trees which are migrating northward, are found upon branches of the St. John which flow from the south and not on those flowing from the north.

2. Floods may tear out root-stalks, fruits and other parts of plants and carry them to situations in which they can grow when the floods subside, but here, also, we can have no adaptation—only incidental locomotion.

3. Entire plants or their vegetative parts may be carried by currents. This occurs with many algæ. The plant may let go its hold on the bottom, float down stream and later take root again, as in *Nasturtium lacustre;* or it may float normally throughout its life as in *Lemna* and *Salvinia*, the water hyacinth of Brazil, which makes floats of its swollen leaf-stalks, and others. Detachable buds are common in water-plants, which are either lateral and protected by bracts as in *Potamogetons*, or condensed

branches or terminal buds as in *Utricularia.* Willow twigs may be carried to grow in favorable places.

4. Spores, seeds or fruits may be carried by currents. To make seeds or fruits float, air chambers develop in some parts, and the latter are usually resistant to decay. Occasionally by waxy substances, the parts are made unwettable and hence float. The receptacle is said to provide the float in *Nelumbium,* the ovary in *Alisma, Sagittaria,* and species of *Carex,* separate carpels in *Nuphar,* ovary and calyx combined in the cocoanut whose salt-water-resisting air-filled husk and unwettable outer skin, make it perfectly adapted to long ocean voyages; the arillus or third seed-coat is used in *Nymphaea.*

5. Rain-drops may wash spores or seeds from their capsules and carry them away in rivulets to grow in damp places. The little gemmæ are thus carried from the cups on the fronds of some liverworts, as *Marchantia,* and perhaps the bublets may be thus carried from the axils of the leaves in lilies and ferns. The pods of *Anagallis* and *Brunella vulgaris* are said to open in a rain which then washes out the seeds.

VI. Locomotion by the Utilization of the Movement of Animals.

There are two fundamentally distinct ways in which the locomotive power of animals is used by plants for their locomotion; first, parts are made to cling to their fur or feathers or feet; second, seeds protected from digestion by special coats are enclosed in fleshy fruits which are eaten, and the seeds are later discharged uninjured from the animals' bodies.

Looking over the groups of animals, we find that the only ones large enough to carry seeds and fruits, and at the same time of active habits and wide range, are birds and mammals. In special cases, however, insects, snails and even fish may carry seeds.

The different types of dissemination are as follows:

1. Vegetative parts provided with hooks may be carried by fur of animals, as in some cactuses, and possibly the stems with their fruits of our galiums, and *Polygonum sagittatum* may be carried in the same way. Winter buds and other parts of water plants may be carried in mud by the feet of birds as in *Elodea canadensis.*

2. By clinging apparatus of hooks, etc., seeds or fruits may become attached to wool or fur and be carried far, to be finally brushed off or to be shed with them, or spines may be developed which stick into the feet of animals. Mammals, because of their shaggy coats, are best adapted for this mode of dissemination, and accordingly it is common in herbs, and rare in shrubs or trees. Hooks, more or less large and strong, are formed from bracts as in the burdock, from outgrowth of the calyx as in Agrimony, calyx teeth as in *Compositæ*, ovary or part of it as in *Desmodium*, inferior ovary as in *Umbelliferæ*, *Circaea*, the style as in *Polygonum virginianum*, the seed itself as in *Villarsia nymphaeoides.* Hooked fruits are numerous but hooked seeds rare, for in the ovary where many are closely pressed together there is not room for the development of hooks. Spines which project straight from the fruit and stick into the hoof of animals occur in a few plants, and in other cases there are formed many projections arranged in lines so that the fruit clings in wool or hair as a comb does.

3. A sticky substance is formed which makes fruits or seeds cling to the fur, feathers or feet of animals, a peculiarity particularly common in water-plants. This may be formed either by special glands or simply over the general surface. It may be on the calyx as in *Salvia glutinosa* and *Plumbago*, in the ovary as in *Linnæa borealis*, on the seed itself as in *Collomia*, and rarer cases are known where it occurs upon other parts. In parasites the seeds are usually sticky, but doubtless this is as much to make them cling to branches as to secure locomotion.

Another very important phase of this subject is the carrying of seeds in the mud which clings to the feet of birds and hoofs of mammals, an extremely effective mode of locomotion. Birds nearly always carry some mud and seeds with them from pond to pond, and doubtless this is the explanation of the extremely wide range of most bog and water-plants.

4. The heavy nuts of trees are moved to some extent by squirrels and other small animals, which carry them off for food. Many are dropped by them *en route*, and others are stored up but never used and may come finally to the ground and germinate. Blue Jays are said to store up quantities of nuts which they never use. Probably oaks, hickories, etc., secure a part of their locomotion in this way. Such seeds are not intended to be eaten and many of them have a bitter taste which to some extent prevents it.

5. By the development of nutritious and pleasant tasting pulp in which seeds, protected from digestion by hard coatings, etc., are imbedded, animals are made to carry seeds for long distances, discharging them finally from their bodies under conditions most favorable for germination. This is the true philosophy of edible fruits in Nature. To protect them from being eaten before the seeds are ripe, they are usually green in color and may even possess spines or stinging hairs, but have some bright color making them as conspicuous as possible when they are ripe. Thus when they ripen early in the season they are red, this color contrasting the best with the green of foliage —but when they ripen after the foliage has turned red, they are often purple, and when they grow in dark or shaded places, they are often white, as in many parasites. Birds are particularly adapted to this mode of dissemination. Their smaller size and habits make it possible for the plants to attract them more readily than the larger mammals; hence berries are particularly common on trees and shrubs, less so on low herbs, though they do occur upon the latter and are eaten by ground birds. Though many seeds become destroyed in the animal's body, many others pass through without injury, and in some cases actually germinate better than these which have not been swallowed. The seed may be made indigestible either by its coats becoming

stony as in the grape, or by inner part of the ovary ripening to a stone as it does in the peach and cherry. In many cases the seeds are enclosed in a core which is not eaten but thrown away after being carried some distance. Seeds escape being crushed by the teeth either by their minute size, or by being large and bitter, or by being very slippery, or by being too hard.

The pulp may be formed from bracts as in juniper, from the receptacle as in the strawberry, from the calyx as in wintergreen, from wall of the ovary as in the grape, from placentæ as in watermelon, from the arillus as in mace, yew, from the funiculus as in some cactuses, from hairs on the interior wall of the ovary as in aroids and the orange, or the pulp may be formed from several of these combined.

6. In some plants, seeds or fruits, more or less protected by hard coats against danger of digestion, look so remarkably like insects that it is believed by some botanists that their resemblance is not accidental but the result of adaptation, and that they are swallowed by animals in the belief that they are insects, and are later discharged uninjured. Such are the seeds of the castor bean and of *Jatropha*, which resemble beetles, and fruits of *Scorpiurus* and *Calendula* which resemble caterpillars. But the subject is not yet settled. In other cases very brightly colored seeds may be swallowed precisely as other brightly colored objects, such as bright pebbles, etc., are. Certain seeds, *Melampyrum pratense*, resemble very closely the eggs of ants and are probably carried off in that belief.

7. Man has produced great effects upon plant locomotion. He has carried useful plants from one continent to another and through all lesser distances: along with the seeds of these, he has accidently introduced others, which may run wild and become weeds, and finally in various accidental ways he has scattered them around the globe. All of this locomotion is, however, of the incidental, not of the adapted kind.

VII. Utilization of the Power of Gravitation.

As already pointed out this force working in a vertical instead of a lateral direction is of little use in dissemination. It causes seeds to roll down slopes, and undoubtedly aids in the scattering of heavy nuts, which have their outer walls so built that they are elastic, and, falling with force they may strike stones or roots or lower branches and bounce away considerable distances, and this may be helped by wind, water currents, etc.

III. SOME SPECIAL ADAPTATIONS CONNECTED WITH THE LOCOMOTIVE PARTS.

In addition to the adaptations to locomotion proper, there are various arrangements connected with the locomotive parts which we cannot here more than mention. Such are the power of planting themselves by utilization of the movements of hygroscopic tissues which bore them into the ground as in *Erodium* and *Stipa pinnata.* In other cases the fruit stalk turns from the light and places the seeds in clefts of rocks on which the plant grows as in *Linaria Cymbalaria* of Europe. Some plants place their seeds in protective positions while they are ripening, as many water plants which draw them by spirally shortened stems under water. Some seeds have modes of protection against germinating in the fruit, others special arrangements for rapidly absorbing water and perhaps even fastening themselves to the ground. Some fruits open only in favorable weather, others, as in cones of certain pines, appear to open only when scorched by fire, and there are many other arrangements which space does not allow us to mention.

IV. Suggestions for the Study of Plant Locomotion by Local Botanists.

From the foregoing outline, which is intended to be suggestive rather than exhaustive, it will be perceived that in plant locomotion, local botanists have a most attractive and profitable field for study. There is opportunity for a great amount of original work in it. These questions have been much studied in Europe, but very little in this country, and it is needful that every species shall be examined here, whether studied elsewhere or not.

The student may start with the assumption that every plant has some mode of locomotion; his task is simply to discover what that is. To do so he has only to watch closely enough the plant especially as it passes from flower to fruit. Then secondly, it will help him if he studies the locomotive agencies and observes what plants are moved by them. He should, for example, watch the berries to see what animals eat them, and the birds to see what berries they eat. The seeds floating on water or driven along the roads by wind, or which cling to his clothing or the fur of animals, or (if he be also an ornithologist,) which occur on the feet or in the stomachs of birds should be collected and identified. To aid in this latter work, he should make collections of seeds and fruits of our water plants; indeed our natural history societies should make such collections as a part of their museums. A collection of seeds and fruits of native plants arranged according to agencies of locomotion would be most instructive and interesting as well as valuable for comparison. The botanist who would undertake as his specialty to work out the locomotion of every plant in a given district and to make a collection of seeds and fruits to illustrate it would have a no less interesting and serviceable specialty than he who works out the occurrence of plants in a given district and collects an herbarium to illustrate it; indeed in the present state of knowledge he would have one likely to be of even more real service to science.

There is need also of experiment. How far certain seeds may be carried by winds of certain strength; how long seeds may float in water without losing their power of germination; what seeds resist digestion while passing through the bodies of animals, and many other principles still need that statistical study which is the only foundation for true knowledge.

I would propose finally to the botanists of Acadia that they should communicate their original observations upon locomotion and other biological topics to this society, and that the society publish them in brief, precisely as it has published notes on plant distribution, and that nothing should be admitted to the list which does not rest upon direct personal observation. In this way may be systematically collected a body of reliable fact as a basis for further elaboration of principle, and as well for the preparation of that true natural history of our native plants which is the real goal of all our endeavors.

Smith College, Northampton, Mass., June 1, 1895.

NOTE, October 5.—As this paper goes to press I find myself well-nigh convinced by recent discussions of the subject that, all things considered, the term *Ecology* is a better one for the study of adaptation than *Biology*. In this case to express the study of plants, *Phytoëcology* would be better than *Phytobiology*.

ARTICLE II.

HISTORY AND PRESENT STATE OF THE ICHTHYOLOGY OF NEW BRUNSWICK.

By Philip Cox, A.B., B.Sc., Ph. D.

CHAPTER I.

Few countries of equal area surpass New Brunswick in the extent and variety of its inland waters. Rivers and streams, lakes and ponds, are scattered over the surface to such an extent as to form, with short portages, water communication between the most remote sections, while the undulating nature of the surface favors the formation of springs and brooks, which, flowing from forest regions, are not only deliciously pure and cool, but sensibly lower the temperature of the larger streams and rivers even at the hottest season of the year. This cooling influence is further increased by the melting of snow often prolonged into early summer, especially in deep and narrow forest valleys and on wooded northern exposures. Thus it happens that the main rivers of the province, the St. John, Miramichi, Nepisiguit and Restigouche, attract swarms of anadromous fishes which enter and thread these watercourses and their numerous tributaries far into the interior. Hence the ocean's flocks and herds are annually spread all over the province, where they linger for weeks or even months; and, as many are the choicest and most valuable food-fishes, the inhabitants are not only supplied with an excellent article of diet, but also enabled to pursue a profitable occupation — catching, selling, and exporting the fish. To enable one to appreciate the value of this industry it is only necessary to state that the salmon, bass, shad, smelt, and alewife, are among these annual migrants; and hence the importance of preserving free from obstruction and pollution the great provincial waterways, which attract and distribute them throughout the interior.

The sea-going forms, however abundant and valuable, constitute only a part of the rich and varied fish-fauna of the province, for the more inland water-system is the home of a variety of food-fishes more or less peculiar to fresh water, such as the whitefish, cusk, togue, winninish, trout and perch, which are thus accessible to the population beyond the range of the more anadromous forms. In addition, the waters teem with many smaller species, not directly valuable as food-fishes, but of much economic importance as furnishing food for the more highly prized species. In this way the whole ichthyology of a region becomes a system of life, whose parts are so mutually essential, so balanced and correlated, that any disturbance, the thoughtless destruction of even the most insignificant forms, may re-act fatally on the whole. To preserve, then, nature's healthy balance, and maintain undiminished the supply of food-fishes, call for an intimate knowledge of the whole ichthyology of the region in question.

Thus, from an economic as well as scientific view, New Brunswick holds out many inducements to students of nature and to practical investigators as well, to examine its varied fish-life with the view of solving the many difficult problems bearing on the healthy maintenance of one of its chief industries and sources of wealth. So far the results have been disappointing; the ichthyology of the province is still in its infancy; nor is it complimentary to the scientific spirit of provincialists to be reminded of the fact that whatever little of a systematic character has been done is, with one exception, the work of foreigners.

CHAPTER II.

The earliest reference to our fishes is to be found in "L'Histoire Naturelle de l'Amérique Septentrionale, par Nicholas Dénys, Paris, 1672." The author lived in Acadie (Nova Scotia and New Brunswick) twenty years or more, and carried on extensive fishing and trading operations at several points on the coast between Cape Breton and Gaspé, especially at Bathurst and Point Miscou in New Brunswick. Though he enumerates but a few species, principally the staple food-fishes and a few others conspicuous by their large size and peculiar habits, and refers to many smaller river and marine forms in a general way, the ichthyological student is able to identify about twenty species at least. As already stated, they are principally the leading food-fishes, such as the salmon, cod, mackerel, shad, herring, trout, haddock, sturgeon, smelt, etc.; but he also speaks of three kinds of rays, a sardine, an anchovy and a flat-fish, which are hard to identify from the very meagre description given. One of the points of greatest interest, however, is found in his description of the "Espadon," which would seem to be the "saw-fish," *pristis pectenatus* Latham * an uncommon visitor, and not, to the writer's knowledge, since recorded on either the coast of New Brunswick or Nova Scotia.

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* "L'espadon est un poisson gros comme une vache, de six á huit piéds de longueur, qui va en diminuant vers la queuë; il a sur le nez un espadon, dont il prend le nom, qui est long d'environs trois pieds, large d'environs quatre bons doigts; il y a de deux costez de cet espadon des pointes longues d'un pouce, de pareille distance les uns des autres, et va étraissessant vers le bout; il ne plye point et est dur et fort roide.—*L'Histoire Naturelle, par N. Denys, Paris, 1672.*"

It is regrettable that our literary, historical, and natural history societies and associations do not take concerted measures to have these old and quaint, but intensely interesting and attractive works, re-published, and thus made accessible to scholars and students of nature, — these "foot-prints on the sands of time."

In "A Historical and Statistical Account of New Brunswick, with Advice to Emigrants," by Rev. W. C. Atkinson, A. M., Edinburgh, 1844, occurs a list of some provincial fishes; but beyond the interest attached to it as one of the earliest catalogues, it claims little attention. From a scientific point of view it is of no value, for besides its many inaccuracies it affords ample evidence of the author's want of knowledge of this section of natural history. He not only includes such extra-limital species as the bluefish, *P. saltator* Lacépède, Spanish mackerel *S. maculatus* Mitchill, and others of similar range, but the squid and shrimp, which are not *fishes* at all; from which it must be inferred that the author of this attractive little book had not a sufficient knowledge of ichthyic physiology to render his determination of species actually observed of much scientific value. The writer, however, finds a pleasure in recommending the little volume to all students of the history of New Brunswick, who must feel grateful to the author for recording much which might otherwise have been lost, of interest in the early settlement and growth of the province.

Three years after appeared "New Brunswick," by Abraham Gesner, Esquire, London, a volume dealing with the geology, settlement, and general resources of the province. The author believed in the universal distribution of the same animal life over any area wherein the same general physical and climatic conditions existed; for the "description of the productions of a single province would apply to almost the whole of the northern part of the great continent" (p. 355); forgetful of the fact that great gaps often occur in the distribution of some special form, even in cases of very restricted faunal provinces, and that the theory becomes more objectionable when sought to be applied to an extensive region. For this reason then, his list, comprising sixty-four species, culled from Richardson's "Fauna Boreali Americana," Pennant's "Arctic Zoology," and several American journals of science, must be viewed with suspicion, nor any surprise felt at the presence in it of many apocryphal, extra-limital, and other doubtful species. At the same time, it must be borne in mind that Dr. Gesner was a man eminent in many branches of science, fully competent to become an authority in ichthyology, did his tastes and opportunities lead that way, and well able to appreciate the worth of scientific methods and accuracy. The "Gesner Museum," the first to be established in the province, bears witness to his great energy and wide attainments. Doubtless, the great majority of species included in his list, and subsequently identified as provincial fishes, were actually observed and determined by him; but the reader is at a loss to know what they are or how to separate them from the rest, consequently no satisfactory criticism of the catalogue can be made.

CHAPTER III.

To Moses H. Perley belongs the honour of having first published a systematic and descriptive list of New Brunswick fishes in a series of "Reports on the Sea and River Fisheries of New Brunswick," Fredericton, 1852. This list became the basis of all subsequent ones, not only for the province, but for Nova Scotia as well. In this the author very modestly claims not to be a professed naturalist, but an *observer* of nature, and for this reason begs indulgence at the hands of critics. A careful examination, however, of the little volume must convince the reader that its author was a scholar of varied attainments, a close and accurate observer of nature, careful and cautious of statement, brief but lucid in narration. A power of condensation and ability to seize the most salient features of form, markings, structure, and habits of fishes, render his descriptions exceedingly pleasing and instructive. If he were not a "professed naturalist" it was due entirely to his modesty; for in the correctness of his determinations and general stability of his list, is found evidence of a high order of scientific knowledge. That he included a few forms, now recognized as the young, or seasonal, or other stages in the life of another species, argues nothing. The general history of ichthyology in America and elsewhere scarcely contains the name of an author, however eminent, whose determinations have not, in many cases, proved incorrect; and it bears additional testimony to our author's scientific acumen that he recognized the minute distinctions on which these so-called species of Cuvier, Valenciennes, Storer, and DeKay were founded; for they were all regarded at that time as specific forms. Moreover, some of these he professes not to have seen, but admitted on Dr.

Storer's authority. Bearing this in mind, it may be said that after forty years Perley's determinations are essentially unchallenged. He established no new species, it is true, for such an opportunity does not fall to every man, and Perley was not a disciple of the more modern school of species-manufacturers, who are flooding the fields of zoology with visionary genera and species; but, in identifying specific or transitional forms already named by the above-mentioned authors, he exhibited an accurate acquaintance with the details of anatomy. It is therefore with more than ordinary pride the student turns to the labours of this pioneer ichthyologist and follows the footprints of the man, the scholar, and naturalist who laid the foundation of the science in New Brunswick.

Perley's list contains the names of sixty-two so-called species; but since his time the development of cyprinids has received more attention, and the "Shining Dace," *Leuciscus argenteus* Storer, has been shown to be the young of the River Chub, *Semotilus bullaris* Rafinesque. Again, the "Salmon Trout," or "White Sea Trout," *S. trutta*, of his catalogue is undoubtly the sea-run or anadromous representative of the common Speckled Trout, *S. fontinalis* Mitchill. Under the name of "Britt," *Clupea minima* Storer, he includes, on the latter's authority, a small herring, which is now regarded as the young of the two ordinary herrings of our coast. The common codfish has perhaps the widest range of any, and must therefore be expected to exhibit much variation in size and colour. One of these varieties is known as the "Rock Cod," which was elevated to specific rank by Storer, Mitchill, and others; and, occurring on our coasts, was very naturally assigned a place in our author's list. Moreover, Prof. Gill has shown that the "Little Sand Dab," *Platessa pussilla*, is the young of the common flounder, *P. plana* Storer, and it must therefore be removed from the catalogue of provincial fishes. Discarding then these five forms, there remain fifty-seven well established species, representing the ichthyological labours of Moses Perley.

The eminent natuarlist, Theodore Gill, M.D., Ph. D., to whose researches the science of ichthyology in America is so largely indebted, published in 1865 a "Synopsis of the Fish of the Gulf of St. Lawrence and Bay of Fundy" (*vide* "Canadian Naturalist," Vol. II., 1865), which was followed in 1873 by a "Catalogue of the Fishes of the East Coast of North America." Though not to be accepted as an authority on provincial fishes, these works proved of much value to subsequent investigators on account of the information they gave respecting species liable to occur in the littoral waters of New Brunswick. For this reason Prof. Gill's name and labours deserve honourable mention, at least, in any review of the progress of ichthyology in Eastern Canada.

Such seems to have been the state of the science in New Brunswick when there arrived in 1866 that versatile writer and accomplished traveller and scholar, A. Leith Adams, M. A., F. R. S., etc., staff-surgeon-major of Her Majesty's 22nd regiment. An admirer of nature, a scientist, already an author of some repute on the natural history of India and the archæology of the Nile and Maltese Islands, he was well equipped through taste and training to enter eagerly the fresh fields this corner of the New World presented. He plunged at once into the wilderness. No difficulty daunted, no toil discouraged him: he bore with cheerfulness the hardships and exposure of long winter journeys through the forest, and the discomfort and torture caused by swarms of mosquitoes and other insect pests during his summer wanderings over the barren lands and inland watercourses. His energy was remarkable; his capacity for intellectual work apparently unlimited. No sooner did he return from a trip of exploration, than dispatching his official duties, and putting the results of late investigations in shape, he was off again to some remote region. Nothing escaped him. He was equally at home in the Indian's wigwam, studying his habits and listening to his traditions—the uncertain twilight of a savage history; collecting stone implements, or digging into the kitchen-middens of some prehistoric camping-ground; in the log-cabin of the back-woods settler, observing the customs of frontier life and learning of the trials and hopes of the hardy pioneer; in the lumberman's shanty away in the depth of the forest, studying woodcraft, the effects of climate, and the winter habits of birds and animals; in the hunter's "lean-to" beside a solitary Indian guide, whither he had gone to observe the battle between the cunning and intelligence of fur-bearing animals and the trapper's craft; along with the chance poacher or pot-hunter to witness with loathing the cowardly and merciless slaughter of the lordly moose as it wallowed helpless, cut, and bleeding in the deep, sharp-crusted snow, in order to be the better able to denounce the barbarous destruction of the noblest game-animal of America; in bark canoe, on river or lake, capturing the finny denizens of the waters, or wading through stagnant ponds and quagmires collecting the oozy reptile; in the trader's storeroom measuring and comparing the skins of animals, and drawing conclusions, alike interesting to the general reader and valuable to men of science; or in rocky gulch of mountain stream, on peaty barren, or bed of tarn, studying the geology of the region.

But while prosecuting his field work with ardor, he was also a student of books, having an intimate knowledge of almost every scientific publication which in any way bore on the natural history of the country, as anyone reading that charming volume, "Field and Forest Rambles," will perceive. This book, containing the results of the labours of six years in New Brunswick, is not only brimful of useful and scientific information, but a real literary gem, written in a style alike pleasing and attractive. In it the scientist, naturalist, and poet, are blended harmoniously; and the dress is now the language of fact and then the gorgeous livery of a lively imagination. A lover of nature in all her various moods, with a strange susceptibility to what is poetic and mystic in her finer influences and manifestations; never more at home than when the winter moon is casting the weird shadows of forest trees on the fleecy mantle around him, or the solitary owl with ominous voice is laughing into the death-like stillness of its lonely haunts; or in canoe on the midnight waters of forest lake, reflecting the pale lights of heaven, and its darkened wall of trees re-echoing again and again the scream of the Northern Diver: Dr. Adams, in his little book whispers of the spirit of the wilderness, and the beauty and charms of its picturesque scenery. And yet, as already observed, the clear, brief, and accurate description of the scientist, will be found to exist side by side with the artist and poet's richness of imagery and charming delicacy of thought and expression.

It is, however, with Dr. Adams, as an ichthyologist and his contributions to the science in New Brunswick the writer has most to deal. He enumerates one hundred and three species, including all those in Perley's list with one or two exceptions, besides twenty-five others on the authority of Dr. Gill (Synopsis of the Fishes of Gulf of St. Lawrence and Bay of Fundy, Canadian Naturalist, 1865); Dr. Holmes' Ichthyology of Maine, 1861–2, and some other American authors; but, as there is no certainty of these having been taken in the waters proper of New Brunswick, they cannot be considered in this review, which seeks to ascertain the number of undoubted species so far recognized. Moreover, further reductions must be made of all duplicated species, where the young or some local or seasonal variety was regarded as a distinct form. . For instance, the landlocked smelt, *Osmerus mordax* Gill, and the landlocked salmon, *S. Gloverii* Girard, were considered as species distinct from the sea-run or anadromous forms, a position no longer tenable; at least more extensive observation and various experiments tend to establish their specific identity. The same remarks will apply to two other nominal species, the New York Shiner, *Leuciscus chrysoleucus* Mitch., and the Banded Dace, *L. vittatus* DeKay, which are specifically equal to the shiner, *Leucosomus Americanus* Storer, and the Red Fin, *Leuciseus cornutus* DeKay. Then again there is, in his catalogue, a Leuciscus, which the doctor did not determine; and, as no specimen has been preserved in our province, it seems impossible to include it in this list.

It will then be apparent that Dr. Adams added eleven species to the known provincial fishes, all of which are certified as having been "verified from personal observation," though it is unfortunate specimens were not deposited in any museum or collection in the province. They are as follows:

Pumpkin Seed, *Pomotis appendix* Mitchill.
White Lake Bass, *Labrax albidus* DeKay.
Many-Spined Stickleback, *Gasterosteus aculeatus* Brevoort.
Sea Raven, *Hemitripterus Acadiensis* Storer.
Labrador or Northern Sculpin, *Cottus labradoricus* Girard.

Sea Swallow, *Dactylopterus volitans* Lacépède.
Radiated Shanny, *Pholis subbifurcatus* Storer.
Thick-Lipped Eelpout, *Zoarces auguillaris* Storer.
Spotted Wrymouth, *Cryptacanthodes maculatus* Storer.
Chub Sucker, *Moxostomus oblongus* Ayres.
Pickerel, *Esox reticulatus* Le Sueur.

It must, however, be borne in mind that Dr. Adams had followed Prof. Gill in the doctrine of "Zoological Provinces," by which, whenever a species is known to occur in any part of a so-called province, it is attributed to the whole. Maine and New Brunswick are so classified by our author (*vide* p. 214); and a Basking Shark, *Cetorhinus maximus* Blainville, taken on the coast of Maine, is referred to New Brunswick in the catalogue "verified from personal observation" (*vide* p. 306, note). In this way, too, the occurrence of the Ghost Fish, *C. inornatus* Gill, in his list may be accounted for.

The history of this fish is interesting as illustrating the general weakness of modern scientists. Every student of nature is well aware that she occasionally shows the wealth of her resources in albinism, melanism, and other strange and accidental variations from a given type. Not many years ago, the writer took a white specimen of the common eel, *Auguilla rostrata* L., apparently in good health and condition. It seems that in 1863 an albino wrymouth, *C. maculatus* Storer, was sent to Prof. Gill of Philadelphia, who proclaimed it a new species, *C. inornatus*, with the significant title of "Ghost Fish." The Spotted Wrymouth is reported by J. M. Jones, F. L. S., as "a rare visitor to Nova Scotia waters," and he adds that a fine albino specimen was taken in Halifax Harbour in 1860, and that such are not uncommon. (Canadian Naturalist, Vol. II., 1865.) It is just possible that Dr. Adams looked upon New Brunswick and Nova

Scotia as constituting a marine ichthyological province, and referred these Nova Scotia specimens to the whole supposed range; but it is more probable that actual specimens from our littoral waters, rare though they be, came under his observation. It is needless to add that the professor's "Ghost Fish" has vanished from the lists of American fishes, but not soon enough to prevent its insertion in the doctor's list. It is unfortunate that localities were not assigned to these new and rare forms, as it would have removed all doubt and misconception. In March, 1894, a very fine specimen of *C. maculatus* was taken in St. John Harbour, and identified by the writer. It was donated to the Natural History Society by Samuel W. Kain of the Customs.

American writers assert that *C. maculatus* has no lateral line; but the specimen in question had a well-defined one on the anterior half of the body, showing a regular line of pores. In spirits it loses its characteristic colouring, rapidly becoming whitish.

A very rare and extra-limital species is the Sea Swallow, *Dactylopterus volitans* Lacépède. It would not excite surprise to have the accidental occurrence of this sub-tropical gurnard reported from the south-eastern shore of Nova Scotia, whither it might stray from its congenial habitat, the Gulf Stream; but its presence in the coastal waters of our province is more than a surprise. In the very nature of things it must be an exceedingly rare visitor, scarcely deserving a place in the lists of our fauna.

Another very uncommon fish is the Radiated Shanny, *Pholis subbifurcatus.* It was first described by Storer, "Report on the Fishes of Mass., 1839"; but its presence in provincial waters was first recorded by Dr. Adams. The next mention is by J. M. Jones, who reports its capture in a trawl net off Halifax Harbour by the Speedwell Expedition of the United States Fishery Commission,

1877. (See List of the Fishes of Nova Scotia, Nova Scotia Institute of Nat. Sc., Vol. V., Pt I., 1879.)

The Sea Raven, *H. Acadiensis* Storer, is not by any means a rare fish in St. John Harbour, where it is taken in the weirs. Several of such specimens have been examined by the writer. Both it and the Thick-lipped Eelpout, *Zoarces auguillaris* Storer, occur in the Miramichi Bay. *Z. ciliatus*, a variety of the latter, is found in the same bay. They differ in the relative size of the head and jaws.

The fresh water species, *Moxostomus oblongus* Ayres; *Esox reticulatus* Le Sueur; *Pomotis appendix* Mitchill; and *Labrax albidus* DeKay, call for a few observations.

The first, known as the Chub-sucker, is quite common in small lowland streams; but is disappearing from its former haunts since the introduction of the pickerel. The latter had not been planted in the waters of New Brunswick in Perley's time; but has become quite common in the lower course of the St. John, which is the northern limit of its distribution in the province. The third, *Pomotis appendix*, is a percoid fish, locally known as the "Long-eared Sun-Fish," and quite common from Maine to Louisiana. Dr. Adams assigns no locality for it in New Brunswick; but the White Lake-Bass, he tells us occurs in "Oromocto Lake, one of the headwaters of the Magaguadavic." Special inquiry was made by the writer about this fish from settlers around the lake, but none had ever seen it.

The Many-Spined Stickleback is found all over the province; but the Northern Sculpin does not appear to have been observed on our coast since his time.

To sum up: Perley identified fifty-seven specific forms, Dr. Adams added eleven new ones, making a total of sixty-eight species, as the joint work of these two pioneers.

CHAPTER IV.

A few additions have been made since, and it will be the writer's object to describe them in greater detail. All have been deposited in the Natural History Museum, St. John; and whenever a doubt existed regarding the determination some of the best authorities in North America were consulted.

Couesius plumbeus Agassiz. This is a species new to our provincial fauna. Wm. M. McLean, Principal of the St. John Grammar School, and the writer collected several specimens from the upper St. John and Madawaska rivers, as well as from the Squattook and Temiscouata lakes drained by the latter, in July, 1893. They are small cyprinids ranging from three to five inches in length, and varying greatly in detail according to locality, the extremes of a series seeming to constitute well-marked sub-species. Some of the constant features may be here briefly alluded to.

The scales are cycloid in form, and about seventy may be counted in the lateral line, eleven between it and the dorsal, and eight between the lateral line and the ventrals. The dorsal is inserted slightly behind the last ray of the ventral, and has eight rays, the anal fin having an equal number. The large eye is contained one and one-fifth times in the snout and one and one-third times in the interorbital space; the mouth is terminal, and the maxillary scarcely reaches the orbit.

On the other hand the coloration is extremely varied. In some specimens the plumbeous lateral band is scarcely distinguishable; in others nearly black: in the majority the body is fusiform; but in a few, heavy and chub-like anteriorly. Some strange anomalies occur. One specimen had the scale formula 12–70–9, the snout very short, the head broad and flattish, and the lateral band invisible.

Being denizens of both fluviatile and lacustrine waters, much variation must be looked for, even in those details of general physiognomy which are regarded as specific of fishes of more uniform habitat and restricted range. Food, temperature, and the character of its general environment must, in time, stamp their influence on the less persistent structural elements of the creature so conditioned, and slowly produce that divergence of type to which the very existence of species is doubtless due. The cyprinids are peculiar among fishes in this respect, which renders the family one of the most difficult to diagnose and classify. Moreover, there is much confusion at present in the literature relating to the genus *Couesius*, and a more thorough examination of a large amount of material from various sources may perhaps show that many of these apparently aberrant forms may be entitled, if not to specific, at least to sub-specific distinction,

Couesius prosthemius Cope.

Though this distinguished herpetologist and naturalist considered this form a good species, there are many reasons for simply regarding it as a strongly marked variety or perhaps sub-species of *C. plumbeus* Agassiz. Even Günther adjudged it of specific rank (*vide* VII. p. 442); but the writer is not aware that he had then seen the last described species. This fish occurs in Loch Lomond, St. John County, where it was identified by the writer in June, 1893. It is very abundant, and would seem to attain a larger size than in any other recorded place in America, except perhaps in Lake Superior, some specimens being over six inches long. The following description will suffice: Body elongate, sub-fusiform, heavy anteriorly; back slightly arched; head rather small, and mouth inferior and oblique rather than terminal as in *C. plumbeus;* snout descends abruptly. Eye small, contained four times in the length of the head, which latter is contained four-and-a-half times in the body. Profile of head straightish, flattened on top, with a slight medium depression. Dorsal inserted over last ray of ventral, and like the anal has eight rays. The scale formula is 11–64–8, varying slightly in different individuals. Coloration: Above almost black, below whitish, lateral band dusky.

This fish spawns about the middle of June, when the top of the head, and scales of the lateral and dorsal parts, are beset with minute horny tubercles, rendering it harsh to the touch.

Loch Lomond is drained into the Bay of Fundy by the Mispeck river, and has, therefore, no fresh-water connection with the St. John or any other river system. Hence this form is localized, confined, as it were, to a very limited lacustrine area, and does not exhibit the aberrant character of the last species.

A single specimen of *Couesius* was taken from Spruce Lake, St. John County, by the writer in September, 1893, which differed in some particulars from either of the two above-described, and is evidently the form reported from Free Port, Maine, by W. C. Kendall and Hugh M. Smith (*vide* Bulletin U. S. F. Com., pp. 15–21, 1894).

The body is fusiform, its depth being four and three-quarter times in its length. Profile very much arched. Head conic, convex on top, four and a quarter in body. Mouth terminal. Eye large, three and a quarter in head. Scales 10–60–7, D. 8, A. 9. Teeth 1.4–4.2. Length, three and three-quarter inches. Colour: dark —

olive above, whitish below; an intensely dark band around snout, expanded on opercle, and ending at the base of the caudal in a rhombic-shaped spot. Cheeks, axils of paired fins, and base of anal, bright red.

The intensely dark lateral band, strong convexity of dorsal outline, teeth and scales, would, if constant, entitle this fish to sub-specific rank. It bears a close resemblance to *C. greeni*, from Fort St. James, B. C. (*vide* Bulletin Natural History Society of B. C., 1893). The strikingly arched character of the anterior dorsal region, in which the head, too, participates, was also observed, but to a less extent, in smaller specimens of *C. plumbeus*, and may be a feature of the immature fish; but this is rather opposed to the general rule that dorsal convexity increases with age, though cephalic flattening may take place. On the whole there is need of a wide and thorough investigation to settle satisfactorily the many obscurities in connection with this whole genus.*

Phoxinus neogaeus Cope. Minnow.

In 1888 this little cyprinid was first reported from the province by the writer, who collected some in a small pond in Maugerville, Sunbury County; and in May, 1893, he described others from Dark Lake, in the vicinity of St. John. In September of that year specimens were taken from Garnett's Lake, a few miles from Loch Lomond, and others were obtained from a small pond near Anagance, Kings County. The Maugerville specimens are larger than the Michigan and Iowa fish first described by Prof. E. D. Cope, of Philadelphia, in 1886, being four inches long instead of three. The body is roundish, compressed posteriorly, the profile being nearly straight. Head large, compressed laterally. Mouth large oblique, with a narrowed and bluntish snout, and the lower jaw projecting. The maxillary reaches the front of the eye, which is large, and contained three and a half times in head, three-quarter in snout, one and a third in interorbital space. Fins well developed. The height of the dorsal equals the length of the pectoral, or the distance between the pupil and posterior margin of the opercle. Dorsal inserted behind the anal and midway between the front of the orbit and base of caudal. The scales are small, much embedded in the skin, and showing about eighty-two in a longitudinal series. Lateral line incomplete, disappearing a little in advance of the dorsal. Back dusky, sides with a dusky band, a lighter one above; below whitish. Dorsal and caudal dusky, the other fins light, edged with dark. Head four, and depth four and a half times in body. D. 8, A. 8. Teeth 2.4–4.2 on pharyngeals. These specimens were obtained in July after the spawning season when they were likely out of condition, which may account for their attenuated and compressed form, dull colour, and the absence of crimson on sides and in axils of pectoral fins, which is said to be characteristic of the Michigan fish.

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* While this article was going through the press, the writer took many specimens of this variety from the Water Works Lake, some miles from St. John. As the localities are remote and specimens identical, it would seem to point out this form as a well marked sub-species.

The specimens from Dark Lake were procured in May and differ in many particulars from the above; but are almost the counterpart of the Anagance variety obtained in September. The largest specimens, and scores were examined, are two and three-quarter inches in length. The head is very heavy; the profile well arched; there is an angle at the nape; the head is curved to the nostrils; the muzzle is short and decurved, with a blunter snout. Anal fin mostly nine-rayed. Dorsal inserted farther back by two-thirds the length of the caudal. Lateral line longer. An intensely black band running from snout to caudal, forming a broad conspicuous patch on operculum. Head three and two-thirds, and depth four times in body. Sides below lateral band rosy. Females larger and more richly coloured than the males. Gill-membranes not forming a fold at the isthmus. Branchial leaflets stouter, oblong not acute, filling gill cavity completely and causing it to bulge. Gill rakers shorter, less acute and with broader bases. Teeth 2.4—4.1 or 4.0, more acute and hooked. The Garnett lake variety are almost the counterpart of the Maugerville specimens, reaching a length of five inches.

While these differences may not be entitled to specific recognition, it must be remembered they are constant, and many species have been established upon fewer and less important characters; nevertheless, the writer believes that this principle has been pushed to an unwarranted length, needlessly multiplying species and perplexing the whole science of ichthyology. Just how far modification must extend, and what structural and other diversities must exist before a species can be declared, will always be a subject of contention; still it behooves men of science to be as conservative as possible, and slow to stamp with natural isolation and finality forms which are but initial steps in that process of development which matures in the production of well-marked species. These little fishes furnish a good illustration. They occur only in small ponds, widely separated, and from which predaceous fishes are entirely excluded, each set having a very restricted range with conditions of life peculiar to itself. As the creature is but the vitalized history of its environment, when the latter differs in two or more cases, dissimilar products must result. In this way what may have been in past ages a fairly uniform species, scattered over an immense area more or less accessible to all, has, in more recent times, and under the results of drainage and from other causes, either become extinct, or maintained its existence in small and isolated areas, becoming in time a form peculiar to its own surroundings. Dark Lake, with a name suggestive of its shaded waters, and the little woodland pond at Anagance, hidden away in the sombre forest, would be expected, other things being equal, to affect an ancestral type in the same way; while the marshy pond in Maugerville, with extensive grassy intervales on all sides, and Garnett's lake, with its peaty bottom and surrounding heath, must influence alike the varying and less persistent features of a common parent.

Chrosomus erythrogaster Agassiz. Red-Bellied Dace.

The paucity of cyprinid forms in the province has been remarked on, but a closer study of the fauna keeps adding an occasional new species. The latest found by the writer is the above, which occurs in Clear Lake, Lepreaux, and may reasonably be expected to turn up in other places. Doubtless its diminutive size has caused it to be mistaken for the fry of larger species; yet in the breeding season it is a conspicuous and attractive object.

The body is fusiform; head rather bluntly pointed, with mouth oblique and lower jaw slightly the longer. The maxillary scarcely reaches the orbit. Lateral line very short, as in *Phoxinus.* Colour: back pale brown or olivaceous, with a dark vertebral line, and sometimes on large specimens an ill-defined line on each side of it made up of spots, and extending from occiput to dorsal fin, but generally only a few spots are seen. Sides with two dark bands, the upper narrow extending from the head to the tail, frequently broken posteriorly into spots or disappearing altogether; the lower broader, running from the nose through the eye and ending in a dark spot on the tail. Space between the bands and the latter and ventral region silvery, red in spring males. Head three and three-quarters in length. D. 7 or 8. A. 8 or 9. Teeth 5–5. Length of largest specimens two and a half inches.

Some smaller examples show the lateral bands confluent on the caudal peduncle, but otherwise are typical. There seems no good reason for regarding it, with Prof. Cope, as a distinct species.

Uranidea boleoides Girard. The Fresh-Water Sculpin. Miller's Thumb.

The presence of this little fresh-water cottoid in the streams of our province seems to have escaped the notice of previous writers and observers. It is, however, by no means rare; but its habit of skulking under rocks and not taking bait readily, as well as its diminutive size, makes it difficult to detect.

Body sculpin-like, heavy anteriorly; head broad and flat, contained three and a quarter times in body. Mouth large, with the maxillary extending to nearly opposite the pupil, and the preopercular spine sharp. Villiform teeth on jaws and vomer. Pectoral fins large, reaching the third ray of the anal. Dorsal consists of eight spines and seventeen rays; the anal of eleven rays. Coloration: Olivaceous above, with dark spots, whitish below. Length three inches.

This species was first reported from the Restigouche River in 1888 by John Brittain and the writer, subsequently collected by the latter from the affluents of the lower Miramichi, and was found dead in the Madawaska, July, 1893.

Uranidea Richardsoni Jordan and Gilbert. Miller's Thumb. Blob.

To this species are referred specimens taken by the writer from Mill Cove Stream, a tributary of the Miramichi, in the vicinity of Newcastle, April, 1892.

Body stout, with a heavy flattened head, the vertex being depressed, and the body tapering regularly to the tail. The head is contained three and two-thirds, and the depth five times in the body. The mouth is large with the maxillary reaching to the posterior edge of the pupil, and jaws equal. Eye moderate, three and a half in head, one in snout, one-half in interorbital space. Pectorals large, reaching nearly to ventrals. Lateral line well marked, decurved opposite posterior end of soft dorsal. Coloration : dark above, with deeper blotches, dull whitish below ; fins, with exception of ventrals, dark and mottled. Preopercular spine sharp, not hooked, directed obliquely backwards and upwards, the inferior two being feebly developed. Subopercular spine short, directed forwards. The fin formula is, D. VIII.—17. A. 12. P. 13. V. I.—4. Length four inches.

Uranidea formosa Girard. Miller's Thumb.

As its specific name implies, this is among the prettiest of the fresh-water sculpins. The body is fusiform and slender, the head small, slightly depressed on top behind the orbits, narrowed anteriorly. Profile of head rounded. Head is contained four and a quarter times in total length. Mouth small, jaws equal, maxillary reaching the pupil. Eye moderate, four in head, one in snout, one-quarter in interorbital space, the latter with a groove between the very proximate orbital ridges. Preopercular spine moderately developed, acute, slightly curving upwards, with a small one on edge of opercle below. Subopercular spine directed forward and downward, well developed. Lateral line not conspicuous, disappearing opposite middle of second dorsal. Upper parts dusky, mottled, the more or less regular longitudinal rows of spots being somewhat confluent ; sides lighter with spots of orange; under parts orange-yellow. D. VIII—16. A. 11. V. I.—3. Length two and three-quarter inches.

One specimen only of this species was obtained. It was found by W. M. McLean and the writer floating dead in the Madawaska River, a few miles above Edmundston, July, 1893. As American writers report it peculiar to deep lakes, it is just possible it was brought down by the current from Lake Temiscouata, Quebec, fifteen miles above; but this is quite improbable. It is here retained as a New Brunswick fish, for the writer is led to believe that these fresh-water cottoids have a peculiar facility of easy and natural adaptation to almost any condition of life; so that the same species can equally exist in lake or river.

The description and synonomy of the Uranidea of North America are very much confused. Over twenty-five species and a large number of varieties have been described by various authors, especially by Girard in the "Monograph of the Fresh-water Cottoids," but there is little unanimity among them, and the whole genus needs a thorough revision. They affect lakes, rivers, and cool, rocky streams especially, where they must form no inconsiderable portion of the food of larger fishes, as the togue, cusk, trout, and land-locked salmon. They skulk about in the shelter of bottom objects, darting rapidly across interspaces, and disappearing suddenly, showing in their quick and timid movements fear of lurking enemies. Their principal food is found adhering to pebbles and rocks, or creeping on the bottom, and consists of the aquatic larvæ of the larger insects, with worms and fresh-water crustaceans. Their habits, as before stated, and coloration, render them very inconspicuous and hard to detect; but if a few stones be turned over in the bed of almost any stream at low water, the observer will be often surprised at the number of these little denizens skulking there out of sight. In the numerous streams and lakes of the province there must be several species of this genus still unrecognized.*

U. gracilis (Heckel) Putnam. Miller's Thumb.

This species is very slender, with the dorsal fins edged with orange or red, a large mouth, and concealed propercular spine. The maxillary reaches the pupil. In many respects it resembles both *U. formosa* and *U. boleoides*, but can always be recognized by its slender form. It was first reported by the writer from Green River, Madawaska County, in 1894, where it is associated with *U. Richardsoni* and *U. boleoides.*

Coregonus quadrilaterials, Richardson. White Fish.

This salmonoid is found in the river St. John above the Grand Falls and in many of the lakes drained by its tributaries. It is associated with its congener *C. labradoricus* Rich.; but is inferior to the latter in quality of flesh and size. As this is its first appearance in any New Brunswick list, a brief description is here given, taken from specimens collected by Wm. M. McLean and the writer in July, 1893.

Body elongate, roundish, not much compressed. Dorsal aspect not appreciably arched, nearly straight from nape to caudal; ventral aspect curving both ways from base of ventral fins. Head moderate, profile little curved; snout very narrow, pig-like, descending, obliquely truncated, its tip on level with lower margin of the orbit. Preorbital bone as wide as the pupil. Maxillary, wide, short, not reaching the front of the orbit, about four in head. Mouth inferior, small, with no teeth on tongue. Gill rakers short and stout. Coloration: Pale-bluish above, silvery below; sides with dark punctu-

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*Since the above was written, the writer found *U. gracilis* in Green River Victoria County, which he has caused to be inserted above.

lations. Dorsal and caudal dusky; ventrals, anal, and pectorals whitish, the latter margined and deeply pointed with dusky. Head five and a quarter. Depth four and two-thirds. D. 12. A. 11. Scales 9–86–8. Length about twelve inches.

Although, in some details, it bears a close resemblance to *C. Couesi* Miller, and in others to *C. Williamsoni* Girard, it is evidently a local variety of *C. quadrilateralis* Rich., which occurs in the lakes of New Hampshire and and the upper Great Lakes of Canada. Its habits are about the same as those of *C. labradoricus*, except that it is more frequently taken in summer about the mouths of inlets, while *C. labrodoricus* prefers the lakes proper.

About the middle of September the white-fish congregate around the mouths of inlets, up which they swarm to deposit their spawn. Brush and hurdle weirs are built across these streams, with narrow gates or openings through which the fish pass to find themselves entrapped in net pounds surrounding the entrances, and so cleverly arranged that the imprisoned fish cannot escape. In some places a mere pretence is made of complying with some law or custom for providing a free passage, narrow though it be; but in many instances this passage is so narrow and shallow that a fish could not get through without danger of stranding. In the face of such detructive fishing, it is a matter of surprise that they maintain themselves in even their present diminished numbers, as compared with their abundance in former years. When so taken, all are gravid and on their way to the spawning grounds a few miles from the lakes. Indeed, it is quite evident to any one visiting the lake region of the upper St. John, and at all conversant with the habits of the white-fish, that there is pressing need of the enforcement of stringent regulations to preserve to the people this bounty of Providence. Fresh-water and anadromous fishes are more exposed to the ignorance and greed of man, and therefore more liable to extermination than marine food-fishes. For this reason the fishery should be wisely regulated. As evidence of this, the Annual Reports of the Department of Fisheries may be quoted with respect to one district — the region visited by the writer in July, 1893. Only those of 1885–88 are at hand, but they will serve the purpose. Lake Temiscouata and Tuladi River yielded of white-fish in 1885, 600 barrels; 1886, 450; 1887, 420; 1888, 110. Further comment is unnecessary.

Catostomus longirostus Le Sueur. Long-nosed Sucker. The Banded Sucker.

Dr. Leith Adams reports this species occurring in "Sciff Lake Stream of the eastern Schoodic chain of lakes," St. Croix, York County (*vide* F. and F. Rambles, p. 252); but strange to say it is not found in his list. The omission is clearly an oversight.

Wm. M. McLean and the writer took specimens from the upper St. John, Madawaska, and the Tuladi lake, the latter in the Province of Quebec, during a tour of investigation in the summer of 1893. Moreover, Indians report it from the upper waters of the Tobique, but its occurrence there is doubtful, otherwise its presence might be reasonably looked for in the lower affluents of the main river.

The two specimens examined by Dr. Adams were from five to six inches in length; and though they average two or three inches more on the upper St. John, the New Brunswick representatives, so far as known, are much smaller than those of the Great Lakes and more western and northwestern waters of North America, where they exceed the common sucker, *C. Commersoni*

Lac., which attains in New Brunswick a length of eighteen inches. The flatter and longer head and snout, broad rosy band, coarsely tuberculate lips, and minute scales, distinguish it readily from the common species, especially in the breeding season.

Very little is known definitely of the movements of this fish. From what the writer observed and could learn from settlers and Indians, it seems to prefer in summer cold, rapid streams and the deep waters of lakes, being in this respect very unlike the common variety, which finds a congenial home on the gravelly and muddy bottoms of even sluggish streams. In June large specimens are said to be quite common, moving up the thoroughfares of lakes in company with the spotted trout; but their summer habitat is not well known. The immature fish seem to frequent, in summer, lakes and the lower stretches of rivers, at least many are found in such places. As the writer has pointed out a correspondence between the fish faunas of the St. John and Restigouche (*vide* Bulletin No. XI. Natural History Society, St. John), the long-nosed sucker will likely be found in the latter river.

Gasterosteus inconstans Kirtland. Brook Stickleback. Five-spined Stickleback.

This species was first reported a few years ago by the writer. It is very rare in the northern parts of the province, where its place is taken by *G. pungitius*, L., but it is fairly common in the valley of the lower St. John (*vide* Bulletin No. XI. Natural History Society, St. John).

Apeltes quadracus Mitchill. Shieldless Stickleback.

This is a diminutive denizen of the brackish ditches and ponds that are found in marsh lands near the mouths of small rivers affected by the tides. The specific name *quadracus* refers to its dorsal armature, consisting of *four* spines, three free and one connected with the soft fin. As this seems to be the first record of its presence in provincial waters, where it was found by the writer in October, 1893, a fuller description than usual may be given in an article of this kind.

Body compressed, its depth equalling the length of the head. Dorsal outline arched, highest at insertion of soft dorsal, thence to snout nearly straight. Caudal peduncle very slender, not keeled. No dermal plates. Innominate bones unconnected. Breast covered with a bony plate. Gill membranes connected with isthmus. Free dorsal spines three, the first the longest, and pointing *generally* to the *left*, the second and third to the right and left respectively, but at different angles; the fourth is joined with the soft dorsal. Bases of free spines between two bony ridges. Coloration: dusky above, mottled; silvery below. Ventral spines, coral red. Fin formula: D. III — I, 11; A. I, 8. Length, one and one-half inches. Mouth of Little River, near St. John.

It seems strange that this little fish, actually swarming in the locality referred to, and in the near vicinity of a city of 45,000 people, should have escaped notice so long. It was probably mistaken for a tiny stickleback, which it somewhat resembles.

Prof. Mitchill first described the species (*vide* Trans. Lit. and Phil. Society, I. 430, 1815), and Gill includes it in his "Catalogue of Fishes of the East Coast of North America," Washington, 1873, assigning its range from New Brunswick to Florida. It would seem then that its occurrence in our waters was either known to this author, or more likely inferred, by a projection of the typical fauna of the neighbouring American coast waters to its natural and geographical limit, namely, the head of the Bay of Fundy and southern coast of Nova Scotia (*vide*

"Catalogue of the Fishes of the East Coast of North America," by T. H. Gill, p. 14, note, Washington, 1873).

Scores of specimens were measured, and the maximum length found to be one and one-half inches — a little above half the length they are said to attain farther south. Moreover, two well-defined arrangements of the dorsal spines were noticed, a regular and an irregular alternation; the former having the three free spines respectively alternate in direction, the first pointing to the left; the latter with the first pointing to the *right*, the remaining *two* to the left. Hence the direction of the first spine seems to determine the kind of alternation of the spines themselves. About eighty per cent. of a very large number showed these arrangements in nearly equal proportion; the remaining twenty per cent. fell equally under similar arrangements reversed. This fact appears to have escaped the notice of the writers referred to above, the irregular one being the arrangement of their descriptions.

Fundulus nigrofasciatus Le Sueur. Killifish.

This little cyprinodont is, like the last, an inhabitant of brackish ponds, and among the smallest of the thirteen members of its genus frequenting the coastal and fluviatile waters of eastern North America, being barely two and a half inches in length. It is very tenacious of life, and while natural to salt water can endure a long residence in the fresh element. The writer kept two taken in the mouth of Little River, St. John Co., for seven months in a globe jar in fresh water; and except a slight falling oft in condition, due to the want of proper food, they retained their usual energy. It would not then be surprising did further investigation disclose that the genus is also represented by fresh-water, or, at least, anadromous species in our province.* Indeed the Funduli of North America divide themselves naturally into two groups, one with six branchiostegal rays and confined to brackish or salt water; the other with five such rays and generally frequenting rivers and lakes, being very closely related to, if at all generically different from *Zygonectes*, the species of which, multiplied beyond all reason, are residents of fresh water.

Fundulus heteroclitus L. Mummichog. Salt water Minnow.

This species is rather common in the mouths of rivers in the northern part of the province. It is closely related to the last, from which it differs chiefly in being longer and stouter, the head heavier, thicker and flatter, the oviduct extending nearly to the end of the first anal ray; the under parts, including ventral and anal fins, pale orange instead of white; the females nearly plain, not having, when mature, the narrow black vertical bars characteristic of the former species; no golden spot at front of dorsal and caudal, as in the last form, in life.

Fundulus fasciatus, or the striped Killifish, of Perley's list, is hard to identify, owing to the endless multiplicity of terms and confused nomenclature employed in designating the various species and varieties of this genus. In the very brief description given, he refers to its sides "being of a brassy yellow, tinged with green . . . and two to five longitudinal stripes." Now these characters are said to be peculiar to *F. majalis* (Walb.) Gill; but the latter is among the largest cyprinodonts, being from five to six inches long, whereas Mr. Perley gives the length from one to three. American writers assign the range of the latter from Cape Cod to Florida; so its occurrence in the Bay of Fundy is improbable.

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* Several months after the above was written the author took *F. diaphanus* in French Lake. (See list.) A short description may be here appended: Posteriorly the body is compressed, but in large specimens round and heavy anteriorly. Small examples are generally slender. Head quite flat above. General colour olivaceous with dark spots on the back, sides with from ten to twenty dark vertical bars, after the manner of *F. nigrofasciatus*. Fin formula: D. 13, A. 11; about thirty-eight rows of scales on the side. Length of largest specimens five inches. It seems to be generally distributed on the lower St. John and its affluents.

The Funduli feed upon minute organisms, and are themselves preyed upon by tomcods, sculpins, and trout. In the northern streams the latter are very partial to them, which fact the angler turns to advantage; for the little dainty, hooked through the dorsal fin and struggling at the end of a long line, is too great a temptation for the voracious sea-run trout. When the latter in vast schools enter the river at high tide, and spread out over the submerged flats, the little Funduli are greedily devoured; and were it not for their cleverness in darting into the oozy mud few would escape. This annual drain accounts for their comparative scarcity in places well conditioned to support them in greater numbers.

Murænoides gunnellus L. Butter Fish.

This shore Blenny is said by Prof. Gill to range from Nova Scotia to Cape Hatteras, and Dr. Adams includes it in his list on the former's authority; but as there is no previous record of its actual occurrence in our provincial coast waters, a more extended notice of its form and habits may now be allowable.

The body is long, narrow, and strap-like, bulging a little in the ventral region, and tapering uniformly towards the tail. Head small, short, compressed, very narrow on top. Occipit flattened, profile suddenly decurving towards snout. Mouth small, oblique, with lower jaw projecting. Teeth in a single row on jaws, except near symphysis; a little patch on the vomer. Gill membranes united, free from the isthmus. Dorsal fin low, extending from near nape to base of caudal, with which it is more or less confluent; all its rays spinous. Anal also confluent with tail, the junction in both cases being marked by a depression. Pectorals short. Ventrals thoracic, rudimentary, composed of one spine and one ray. Coloration: olive above; yellowish below; sides with obscure dark bars. Twelve black ocellated spots disposed quite regularly on base of dorsal. Head eight in body. Depth seven. Fin formula: D. LXXVIII. A. II, 36—38. V. I, 1. Length seven inches.

The above description is taken from two or three of the larger of a number of specimens the writer procured from St. John harbour, in September, 1893. Smaller specimens are brown above, with a dark vertical bar under the eye, and dorsal spots oblong. This fish is said to attain a length of twelve inches. They live in shallow water, gliding among the rocks and seaweed, for which movements their thin eel-shaped and slippery bodies are admirably suited. They seldom retire with the tide, but lie concealed in their usual haunts. Young shell-fish, worms, shrimps, and other crustaceans form their chief food. The species occurs on both sides of the Atlantic.

Stromateus triacanthus Peck. Harvest Fish. Dollar Fish.

This species is quite common on the southern coast of Nova Scotia, and cannot be said to be rare in St. John harbour, where some are taken every autumn in the weirs. It is a scombroid fish, with body flat, thin and ovate, the caudal peduncle being short and slender. The dorsal and ventral outlines are about equally arched. Head short and compressed. Mouth small, with blunt snout, and maxillary not reaching the eye. Teeth minute, weak, on jaws only. Gill membranes not united, free from the isthmus. Lateral line concurrent with the back, and a rudimentary one with the ventral outline.

Dorsal fin long, reaching nearly to caudal, and with a series of pores near the base. Anal fin similar. A few feeble spines, generally three, in front of each. Pectorals long. Colour: bluish above, below white, with silvery reflection. Head four, depth two and a half. The fin formula is, D. III, 44. A. III, 38. Length six inches. A specimen in possession of Wm. M. McLean, St. John, furnished the above description. As is the case with the Sea Raven, *H. Americanus* Cuv. and Val., full-grown Dollar Fish are seldom seen in St. John harbour. They are said to attain the length of ten inches, and to be very palatable pan-fish.

Scomberesox saurus Walbaum. Bill Fish. Saury.

This little pelagic fish is exceedingly rare on our coast. The writer is not aware that it was ever observed in the Bay of Fundy*; and but one instance of its occurrence on the Gulf Shore has come to his notice, when several years ago a specimen was taken on the northern side of Miramichi Bay and sent to the writer by Dr. A. C. Smith, Inspector of Leprosy, Newcastle. It was mounted, but subsequently lost. The body was smelt-like, the scales too, being small, and deciduous. Dorsal outline but little curved. Head moderate, compressed so as to be very narrow below. Jaws prolonged into a slender beak, quite as long as the rest of the head, the lower jaw being the longer. Dorsal opposite anal, and both somewhat broken up into finlets posteriorly. Caudal deeply forked. Head three and a half. Depth eight and a half. D. 9, VI. A. 12, V. Length nine inches.

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*The author has since learned that Dr. Bailey, of the University of N. B., has one from the vicinity of St. Stephen, Bay of Fundy. See list.

Specimens eighteen inches long are reported by various authors. At sea, it is said to accompany schools of mackerel, and old fishermen call it the "Mackerel Guide."

Clupea aestivalis Mitchill. Blue-Back. Summer Gaspereau.

In habits and a few points of structure this fish differs from the common alewife, and is now regarded as a distinct though closely allied species. The eyes are smaller, and the fins not so well developed. The peritoneum is black. The average size is much smaller than the spring gaspereau. They enter fresh water late in June and ascend rivers to spawn; but do not frequent small streams, ponds, and shallow lakes as the ordinary alewife does, seeming to prefer the lower courses of rivers for that purpose. Although very fat and delicious as a pan fish, few of them are caught and cured. Their range is co-extensive with that of the larger spring species, which has led many to look upon them as the young of that variety.

CATALOGUE OF THE MARINE AND FRESH-WATER FISHES OF NEW BRUNSWICK.

BY PHILIP COX, A. B., B. Sc., Ph. D.

The following list is based on a "Descriptive Catalogue of the Fishes of New Brunswick and Nova Scotia," by Moses H. Perley, 1852, and a "List of the Chief Marine and Fresh-water Fishes of New Brunswick" by Dr. A. L. Adams, Field and Forest Rambles, London, 1873, to which are added a number of species since identified by the writer and others as new to the province. Both the lists were critically examined and doubtful species removed; but the writer does not wish to be understood as having examined *all* the forms included, for a dozen or more have not come under his immediate observation; yet the credibility of the witnesses and probability of the occurrence of these species within the limits of provincial waters, as inferred from their well-known range, fully warrant their retention in the list.

The more modern nomenclature, founded on priority of use and the better understood relations of families and genera, has been adopted; and, as the result, the classification is essentially that of Jordan and Gilbert, based on the views of Gill and Cope. (*vide* "Synopsis of the Fishes of North America," by D. S. Jordan and C. H. Gilbert. Bulletin No. 16, Smithsonian Institution, Washington, 1882).

Out of respect to the memory of the pioneer ichthyologist of the province, the writer, in assigning localities and ranges, quotes from Moses H. Perley. It is only when these limits seem too restricted for a provincial list he departs from the rule. The technical name used by the same author is also given as a second designation.

FAMILY I.—PETROMYZONTIDÆ.

GENUS 1. PETROMYZON Linnæus.

Species 1. P. marinus L., **P. Americanus** Storer.
The Lamprey.
"Atlantic coast, ascending rivers to spawn."

FAMILY II.—SPINACIDÆ.

2. SQUALUS Linnæus.

2. **S. acanthias** L. *Spinous Dog-fish, Picked Dog-fish.*
"Atlantic coast." Rare on northern shore.

FAMILY III.—ALOPIIDÆ.

3. ALOPIAS Rafinesque.

3. **A. vulpes** Bonaparte. **Carcharias vulpes** Cuvier.
Thresher Shark. Swingle-tail.
"Cumberland Bay and Bay des Chaleurs."

FAMILY IV.—CETORHINIDÆ.

4. CETORHINUS Blainville.

4. **C. maximus** L. *Basking Shark.*
"Musquash Harbour." *Selachus maximus.* Adams.

FAMILY V.—RAIIDÆ.

5. RAIA Linnæus.

5. **R. erinacea** Mitchill. *Little Skate. Hedge-hog Ray.*
"North Head, Grand Manan."
Gulf of St. Lawrence Coast.

6. **R. lævis** Mitchill. *The Skate. Barndoor Skate.*
"Everywhere on the coast of New Brunswick."

FAMILY VI.—ACIPENSERIDÆ.

6. **ACIPENSER** Linnæus.

7. **A. sturio** (variety **oxyrinchus**) L. Sturgeon.
"Ascending large rivers from the sea."

FAMILY VII.—SILURIDÆ.

7. **AMIURUS** Rafinesque.

8. **A. catus** Gill. **Pimelodus catus** LeSueur.
Horned Pout. Catfish.
"In all ponds and streams where the Yellow and White Perch are taken."

FAMILY VIII.—CATOSTOMIDÆ.

8. **CATOSTOMUS** LeSueur.

9. **C. commersoni** Jordan. **C. communis** LeSueur.
Common Sucker. Brook Sucker.
"In all rivers and streams."

10. **C. longirostris** LeSueur. *Long-nosed Sucker.*
"Eastern chain of Schoodic Lakes." Adams.
Madawaska and Upper St. John.

9. **ERIMYZON** Jordan.

11. **E. sucetta** Jordan. *Chub Sucker.*
Moxostomus oblongus (Gunther) Adams. (No locality.)
Small tributaries of Lower St. John; rare.

FAMILY IX.—CYPRINIDÆ.

10. **CHROSOMUS** Rafinesque.

12. **C. erythrogaster** Agassiz. *Red-bellied Dace.*
Clear Lake, Lepreaux.

11. **MINNILUS** Rafinesque.

13. **M. cornutus** Mitchill. **Leuciscus cornutus** Gunther.
The Red-fin.
"Swift and limpid streams."

12. RHINICHTHYS Agassiz.

14. **R. atronasus** (Mitch.) Agassiz. **Leuciscus atronasus.** *Black-nosed Dace. Brook Minnow.*
"In almost every brook."

13. COUESIUS Jordan.

15. **C. prosthemius** (Cope) Jordan.
Plentiful in Loch Lomond, near St. John. A probable variety in Spruce Lake.

15. **C. plumbeus** Agassiz.
Madawaska and Upper St. John.

14. SEMOTILUS Raf.

17. **S. corporalis** Mitchill. **Leuciscus cephalus.** *The Chub. Horned Dace.*
"Every river and stream."

18. **S. bullaris** (Raf.) Jordan. **Leuciscus pulchellus** *et* **argenteus** Storer. *Roach Dace. Silver Chub.*
"In swift water, eddies, and pools."

15. PHOXINUS Agassiz.

19. **P. neogæus** Cope. *Minnow.*
Pond in Maugerville, Garnett's Lake and Dark Lake, St. John County, and a pond near Anagance, Kings Co.

16. NOTEMIGONUS Raf.

20. **N. chrysoleucus** Mitchill. **Leuciscus chrysoleucus.** *Golden Shiner. Yellow Shiner.*
"Near Hampton Ferry." French Lake and adjacent ponds and streams, Sunbury; Belleisle; and Peabody Lake, Northumberland.

FAMILY X.—CLUPEIDÆ.

17. **CLUPEA** Linn.

21. **C. harengus** Linn. **C. elongata** LeS. *Common Herring.*
"Caught on the shores every month of the year."

22. **C. mediocris** Mitchill. **Alosa mattowacca.**
Fall Herring. Hickory Shad.
"Near Campobello."

23. **C. vernalis** Mitchill. **Alosa tyrannus.**
Alewife. Spring Gaspereau.
"Bay of Fundy and Miramichi Bay."

24. **C. æstivalis** Mitchill. *Blue Back. Summer Gaspereau.*
Co-extensive in range with the latter species, but entering rivers later in the season.

25. **C. sapidissima** Wilson. **Alosa sapidissima.**
Common Shad.
"Bay of Fundy and Miramichi Bay." Occasional in Baie desChaleurs.

18. **BREVOORTIA** Gill.

26. **B. tyrannus** Goode. **Alosa menhaden.**
Menhaden. Mossbunker.
"Harbour of St. John."

FAMILY XI.—SALMONIDÆ.

19. **MALLOTUS** Cuvier.

27. **M. villosus** Cuv. *Capelin.*
"Never ranging further south than the shores of New Brunswick."

20. **OSMERUS** Linnæus.

28. **O. mordax** Mitchill. **O. viridescens.** *The Smelt.*
"Abounds in New Brunswick." "Land-locked in many lakes." Adams.

21. **COREGONUS** Linnæus.

29. **C. labradoricus** Richardson. **C. albus.**
White-fish. Gizzard Fish.
"Madawaska River, Eagle, St. Francis and Grand Lakes, and Lower St. John." Upper Restigouche River.

30. **C. quadrilateralis** Richardson. *Round Whitefish.*
Madawaska and Upper St. John.

22. **SALMO** Linnæus.

31. **S. salar** Linn. *Atlantic Salmon.*
"Bay of Fundy and Gulf of St. Lawrence." Land-locked in Loch Lomond, Sciff Lake and Musquash Lake, becoming the wininnish of authors.

23. **SALVELINUS** Richardson.

32. **S. namaycush** Walbaum. **Salmo ferox.**
Togue. Tuladi.
"Found in all the large lakes of New Brunswick, including the Miramichi Lake and Loch Lomond."
The author was misled regarding its occurrence in Miramichi Lake. It is not found in the river and lake systems between the Restigouche and St. John. No other record of its presence in Loch Lomond is known. Was the wininnish mistaken for this fish? States Brook Lake, Restigouche.

33. **S. fontinalis** Mitchill. **Salmo fontinalis** *et* **trutta.**
"Nearly every lake and Stream." Anadromous specimens constitute the S. trutta of Perley's list.

FAMILY XII.—CYPRINODONTIDÆ.

24. **FUNDULUS** Lacépède.

34. **F. diaphanus** LeS. *Spring Minnow.*
French and Grand Lakes, Sunbury and Queens Counties; Belleisle and St. John River.

35. **F. nigrofasciatus** (LeS.) Cuv. and Val. *Killifish.*
Mouth of Little River, St John.

36. **F. heteroclitus** Linn. **F. fasciatus?**
Salt-water Minnow. Killifish.
"In salt-water creeks along the coast generally."

FAMILY XIII.—ESOCIDÆ.

25. **ESOX** Linn.

37. **E. reticulatus** LeS. *Green Pickerel.*
"Not hitherto appeared in any of our waters, although introduced into head-waters of St. Croix." Adams.
Quite common on Lower St. John and its affluents.

FAMILY XIV.—ANGUILLIDÆ.

26. **ANGUILLA** Thunberg.

38. **A. rostrata** (LeS.) DeKay. **A. vulgaris.** *Common Eel.*
"Taken in every situation it can reach." Does not occur above the Grand Falls, St. John River Albinoes sometimes met with.

27. **CONGER** Cuvier.

39. **C. niger** (Risso) Jor. and Gilb. **Anguilla oceanica.** *Conger Eel.*
"A specimen taken in Pokemouche Gully in October, 1849."

FAMILY XV.—SCOMBERESOCIDÆ.

28. **SCOMBERESOX** Lac.

40. **S. saurus** Walbaum. *Bill Fish.*
Bay of Fundy, Dr. Bailey. Miramichi Bay, Dr. A. C. Smith.

FAMILY XVI.—GASTEROSTEIDÆ.

29. **GASTEROSTEUS** Linn.

41. **G. pungitius** L. **G. occidentalis,** *Many-spined Stickleback.*
"Plentiful, spawning in July." Adams.

42. **G. inconstans** Kirtland. *Five-spined Stickleback.*
Not uncommon on the Lower St. John.

13. **G. aculeatus** Linn. **G. biaculeatus.**
Two-spined Stickleback.
"In the estuaries of rivers and in those creeks to which the sea has access."
Quite common in lakes, and on Upper St. John, Madawaska, and Restigouche.

30. APELTES DeKay.

44. **A. quadracus** (Mitchill) Brevoort.
Brackish creeks and ponds about mouth of Little River, St. John.

FAMILY XVII.—AMMODYTIDÆ.

31. AMMODYTES Linn.

45. **A. americanus** DeKay. *Sand Launce. Sand Eel.*
"Everywhere on the coast." **A. tobæanus,** Adams.

FAMILY XVIII.—XIPHIIDÆ.

32. XIPHIAS Linnæus.

46. **X. gladius** L. *Sword-fish.*
"Seen occasionally off the coast of the Bay of Fundy."

FAMILY XIX.—SCOMBRIDÆ.

33. SCOMBER Linnæus.

47. **S. scombrus** Linn. *Common Mackerel.*
"Caught in great quantities on the northern coasts of New Brunswick."

48. **S. pneumatophorus** De la Roche. **S. grex.**
Easter Mackerel. Tinker Mackerel.
"Found everywhere."

34. ORCYNUS Cuvier.

49. **O. thynnus** (Linn.) Poey. **Thynnus vulgaris.**
"Coast of North America, as far south as New York."
Occasional in Baie des Chaleurs.

FAMILY XX.—STROMATEIDÆ.

35. STROMATEUS Linnæus.

50. **S. triacanthus** Peck. *Harvest Fish. Dollar Fish.*
Not uncommon in autumn on Bay of Fundy coast.

FAMILY XXI.—CENTRARCHIDÆ.

36. LEPOMIS Raf.

51. **L. auritus** (Linn.) Raf. **Pomotis appendix** Storer. *Long-eared Sun-fish.*
Dr. Adams assigns no locality. Probably the St. Croix waters, as the species occurs in Maine.

52. **L. gibbosus** Linn. **Pomotis vulgaris.** *Sun-fish. Pond-fish.*
"All the British Provinces." Not known on the St. John above the Grand Falls.

37. MICROPTERUS Lac.

53. **M. dolomieu** Lac. *Small-Mouthed Black Bass.*
Introduced lately into Spruce Lake and other lacustrine waters of the province.

FAMILY XXII.—PERCIDÆ.

38. PERCA Linnæus.

54. **P. americanus** Schranck. **P. flavescens.** *Yellow Perch.*
"Common in almost all the inland waters."
"Spawns early in May." Adams.

FAMILY XXIII.—SERRANIDÆ.

39. ROCCUS Mitchill.

55. **R. lineatus** (Bloch) Gill. **Labrax lineatus.** *Striped Bass.*
"Found on the sea coast, ascending fresh-water streams to breed in spring and for shelter during winter."

56. **R. chrysops** (Raf.) Gill. **Labrax albidus.**
White Bass. White Lake-Bass.
"Two specimens from Lake Oromocto, one of the head-quarters of the Magaguadavic River." Adams.
The only record known to the writer east of the great lakes. An interesting note.

57. **R. americanus** (Gmel.) Jordan and Gilbert. **Labrax pallidus.** *White Perch.*
"Lakes and streams connected with the River St. John."
"Widely distributed." Adams. Rare in northern waters.

FAMILY XXIV.—SPARIDÆ.

40. DIPLODUS Rafinesque.

58. **D. probatocephalus** (Walb.) Jor. and Gilb. *Sheepshead.*
Occasional in St. John harbour.

FAMILY XXV.—LABRIDÆ.

41. CTENOLABRUS Cuv. and Val.

59. **C. adspersus** (Walb.) Goode. **C. cœruleus.**
Sea Perch. Cunner.
"Bay of Fundy." Coast of Gulf of St. Lawrence.

42. TAUTOGA Mitchill.

60. **T. onitis** (Linn.) Günther. **T. americana.**
Tautog. Black-fish.
"Bay of Fundy."

FAMILY XXVI.—SCORPÆNIDÆ.

43. SEBASTES Cuvier.

61. **S. marinus** (Linn.) Lütken. **S. norvegicus.**
Rose-fish. Norway Haddock.
"Bay of Fundy, east of the harbour of St. John."

FAMILY XXVII.—COTTIDÆ.

44. HEMITRIPTERUS Cuvier.

62, **H. americanus** (Gmelin) Cuv. and Val. *Sea Raven.*
St. John Harbour, Tracadie and Miramichi Bay.

45. URANIDEA DeKay.

63. **U. richardsoni** Agassiz. *Miller's Thumb. Blob.*
Mill Cove Stream, Northumberland County, and Green River, Madawaska.

64. **U. boleoides** (Girard) Jordan. *Miller's Thumb.*
Restigouche, affluents of lower Miramichi, and Green River, Madawaska.

65. **U. formosa** Girard. *Miller's Thumb.*
Madawaska River

66. **U. gracilis** (Haeckel) Putnam. *Miller's Thumb.*
Green River. Associated with **U. richardsoni** and **U. boleoides.**

46. COTTUS Linnæus.

67. **C. octodecimspinosus** Mitchill. **C. virginianus.**
Common Bull-head. Long-spined Sculpin.
"Very numerous on all the fishing grounds."

68. **C. scorpius** (var. **grœnlandicus)** Cuv. and Val.
The Greenland Bull-head.
"On all the fishing grounds." The typical **scorpius** is also found in the Miramichi Bay.

69. **C. labradoricus** (Girard) Gunther. *Labrador Sculpin.*
(No locality). Adams.

FAMILY XXVIII.—TRIGLIDÆ.

47. CEPHALACANTHUS Lac.

70. **C. spinarella** (Linn.) Lac. **Dactylopterus volitans.**
Sea Swallow.
(No locality). Adams.

FAMILY XXIX.—CYCLOPTERIDÆ.

48. **CYCLOPTERUS** Linnæus.

71. **C. lumpus** Linn. **Lumpus vulgaris.** *Lump Sucker.* *Lump Fish.*
"Grand Manan." St. John harbour and Miramichi Bay.

FAMILY XXX.—BLENNIIDÆ.

49. **MURÆNOIDES** Lac.

72. **M. gunnellus** (L.) Gill. *Butter-fish.*
St. John harbour and coast of Bay of Fundy.

50. **EUMESOGRAMMUS** Gill.

73. **E. subbifurcatus** (Storer) Gill. **Pholis subbifurcatus.** *Radiated Shanny.*
(No locality). Adams.

51. **CRYPTOCANTHODES** Storer.

74. **C. maculatus** Storer. *Wrymouth.*
St. John harbor.

52. **ANARRHICAS** Linnæus.

75. **A. lupus** Linn. *Wolf-fish.*
"Near Grand Manan and Campobello."
A. vomerinus Adams.

FAMILY XXXI.—LYCODIDÆ.

53. **ZOARCES** Cuvier.

76. **Z. anguillaris** (Peck) Storer. *Eel Pout.* *Mother-of-Eels.*
(No locality). Adams.
Abundant in Miramichi Bay, where both varieties, **Z. anguillaris** and **ciliatus** Mitchill, occur.

FAMILY XXXII.—GADIDÆ.

54. PHYCIS Bloch.

77. **P. chuss** (Walb.) Gill. **P. americanus.** *Squirrel Hake. American Hake.*
"On muddy bottoms in the Bay of Fundy." Rare in Miramichi Bay.

55. LOTA Cuvier.

78. **L. maculosa** (LeS.) Cuv. and Val. *Burbot. Cusk.*
"River St. John, Eagle and St Francis Lakes." Restigouche waters and Lake Utopia.

56. BROSMIUS Cuvier.

79. **B. brosme** (Müller) White. **B. vulgaris.** *Cusk. Torsk.*
"In Bay of Fundy. Not abundant." Occasional on the Miramichi coast.

57. GADUS Linnæus.

80. **G. æglifinis** Linn. **Morrhua æglifinis.** *Haddock.*
"Campobello." (No locality). Adams.

81. **G. callarias** Linn. **Morrhua vulgaris.** *Common Codfish.*
"Grand Manan, Northumberland Straits." More or less common on the whole coast.

82. **G. tomcod** Walbaum. **Morrhua pruinosa.** *Tomcod. Frost Fish.*
"Taken on shores throughout the year." Ascends rivers in January to spawn.

83. **G. virens** Linn. **Merlangus carbonarius**. *Pollock.*
"Bay of Fundy."

58. MERLUCIUS Raf.

84. **M. bilinearis** Mitchill) Gill. **M. albidus.** *Silver Hake.*
"Grand Manan." Occasional in St. John harbor.

FAMILY XXXIII.— PLEURONETCIDÆ.

59. HIPPOGLOSSUS Cuvier.

85. **H. vulgaris** Fleming. *Halibut.*
"Bay of Fundy." Rare on northern coast.

60. PLEURONECTES Linnæus.

86. **P. ferrugineus** (Storer) Jor. and Gilb. **Platessa limanda.** *Common Dab. Sand Dab.*
"Everywhere on the coast."

87. **P. americanus** Walbaum. **Platessa plana.** *Winter Flounders.*
"Everywhere on the coast."

FAMILY XXXIV.— LOPHIIDÆ.

61. LOPHIUS Linnæus.

88. **L piscatorius** Linn. **L. americanus.** *Angler. Fishing Frog.*
"Bay of Fundy." Miramichi Bay.

FAMILY XXXV.— ORTHAGORISCIDÆ.

6. MOLA Cuvier.

89. **M. rotunda** Cuvier. *Sun-fish.*
Bathurst harbour. St. John harbour.

ADDENDUM.

90. **Raia radiata** Donovan. *Starry Ray.*
St. Martins, Bay of Fundy.

ARTICLE III.

THE VOLCANIC ROCKS OF THE MARITIME PROVINCES OF CANADA.

BY W. D. MATTHEW, PH. D.

Read May 7, 1895.

In discussing the volcanic rocks of the Atlantic coast it is convenient in several respects to consider first those of the Maritime Provinces. For —

1. They occur here in as great, or greater abundance than in any of the areas to the south-west of them.

2. They have been recognized as such from very early times, and their extensive occurrence has never been questioned.

3. They are comparatively little altered — less so than many of those in the United States.

4. There is no question as to the age of a large part of them.

It may be as well to outline briefly the general geological structure of New Brunswick in order to make clear the arrangement of the volcanic rocks. The province is divided into three areas of very different geologic features. To the south, fronting on the Bay of Fundy, lies a rugged and hilly region of very complicated geology, consisting largely of north-east and south-west ridges of metamorphic rocks, with the valleys between partly filled by later sediments. To the north of this lies a great triangular area of carboniferous rocks, flat-lying, seldom over three hundred feet in height, fronting on the Gulf of St. Lawrence. North-west of this, and separated by a broad band of metamorphic and intrusive rocks, lies the great Silurian area, mostly high, rolling country, underlain by slaty rocks which are much upturned, but not excessively altered. The division of the province into Southern, Central, and Northern or North-western, is hence a very convenient one.

The formations represented range from pre-Cambrian to Triassic. The pre-Cambrian consists of the highly metamorphic gneissic series, which has been compared to the Laurentian; and the largely volcanic series compared to the Huronian. The Cambrian slates occupy parts of some of the valleys of southern New Brunswick, but are not important areally. The Ordovician or Cambrosilurian consists of much altered slates and sandstones flanking the granitic and pre-Cambrian areas. The Silurian occupies the north-west part of the province, and is less altered than the Ordovician, and very generally fossiliferous. The Devonian consists of slates and sandstones, occupying various small areas both in northern and southern New Brunswick. Along with all the previously formed rocks these have been much folded and upturned and considerably metamorphosed by the mountain-making processes which occurred at its close, and which were far more important in the Maritime Provinces than further to the south-west. The red sub-carboniferous rocks are never much metamorphosed and very generally little upturned, while the grey carboniferous sandstones are usually almost flat-lying. Two or three very small areas of red Triassic sandstone occur along the northern shore of the Bay of Fundy, and are the youngest consolidated strata found in the province.

As far back as 1838 Dr. A. Gesner, in the reports of the Provincial Survey, speaks of the great quantities of volcanic rock in New Brunswick, and continually emphasizes the importance of igneous outbursts in the southern part of the province. He appears to have considered these eruptions as geologically recent, for he connects them with the earthquakes and changes of level within historic times, and considers that "the lofty mountain, the vertical cliff, the foaming cataract, the rude outline, and other sublime features of the district," are to be attributed "to the earthquake and the volcano." He figures in the second report some supposed volcanic cones, of remarkable perfection, considering that they are of pre-Cambrian age. However, his general ideas as to the character of the rocks were correct enough, considering the time of writing.

The Dominion Survey from 1868 to 1888 (?) confirmed the early views as to the character of these rocks, showing the eruptives to be very widely distributed through the province, and to be in part of very early age. It was accompanied by accurate maps constructed on a scale of four miles to the inch.

From the pre-Cambrian down to the Triassic, New Brunswick must have been the seat of great, though intermittent, volcanic activity. Rocks known to be eruptive cover a considerable part of the superficial area, and their thickness is locally enormous. It is probable that they underlie a large area now covered by sedimentary strata.

The oldest rocks in the province are the highly metamorphic gneisses, schists, and limestones, forming the so-called Laurentian. These are entirely sedimentary, showing no trace of contemporaneous volcanic activity. With them are associated large areas of granite, some of which are certainly, and many more probably, intrusive.

Over the Laurentian are great thicknesses of beds composed of surface volcanic rocks, which have been divided into three or four groups in the southern part of the province, but which are conveniently classed together as Huronian, if the term be used in its broader sense, or, if this be disallowed, must be simply called pre-Cambrian. These form the greater part of the southern metamorphic hills, and occur in small patches north of these. The high broken country about the headwaters of the Tobique, Nepisiguit and North-west Miramichi, is composed of pre-Cambrian rocks, largely eruptive, and intrusive granite.

These volcanic rocks are known for the most part only through field descriptions. They are hard, fine-grained flinty rocks, mostly red or dark colored ; some time, though not generally, schistose; and not always recognizable as of igneous origin. Those from a part of the southern metamorphic hills have been studied by the aid of the microscope and are then seen to show all the characteristic structures of volcanic products in great perfection. They evidently were once precisely like the lavas and ash-rocks of modern times. The changes they have undergone are mostly limited to the devitrification of the glassy parts and the partial or complete recrystallization of some of the minerals.

The deep-seated crystalline facies of these effusives is not well known. They may perhaps be the surface equivalents of some of the granites and other intrusives in the Laurentian rocks; but this remains to be proved. Although many instances are recorded by the New Brunswick and Nova Scotia geologists of transitions from granite into felsite, yet none can be taken as satisfactory without the support of thin sections and chemical analyses to prove their identity in composition, and a careful study of the progressive gradations from one to the other.

The general character of the pre-Cambrian volcanics that I have seen is tolerably uniform. They are mostly either feldsparporphyry or diabase, or approach closely to one of these two types. Strongly quartzose porphyries are not common, nor are intermediate rocks of the andesite type, while olivine rocks have not been recognized among the effusives. A soda-granite occurs among the Huronian rocks near Upham, but its relations to them are doubtful.

The Huronian began in southern New Brunswick with rocks exclusively volcanic. These reached in places an enormous thickness (up to 11,000 feet in the Kingston Group at New River), but in places they thin out to a few hundred feet of fine-grained tuffs, or are entirely absent. They are covered by coarse red rocks, conglomerates and shales, which are thought to have been rapidly deposited over an area of dying volcanic activity, and have some interbedded volcanic deposits. After this followed a long period of rest while the Cambrian and Ordovician slates were being deposited. In the neighborhood of St. John there was no resumption of volcanic activity, but in the region about Passamaquoddy Bay the Silurian was again a period of igneous outbursts — of lavas and ashes, which now lie interbedded with the fossiliferous sediments, and form the more prominent hills of that neighborhood. In the northern part of the province, around the upper part of Baie Chaleur, are large areas of volcanic rocks, felsites and traps, which cut through Silurian slates, but appear to be earlier than the Devonian rocks. These effusives form high hills standing out prominently along the shore between Bathurst and Campbellton; at the latter town the Sugarloaf Mountain, rising abruptly over 1,000 feet, is composed of felsite. Smaller areas of volcanic rocks, cut the Silurian slates in other parts of the province; at Moose Mountain, east of the

St. John River, they form a conical hill over 1,000 feet in height, from which a magnificent view of the surrounding country can be obtained. The great development of igneous rocks of this period is, however, at Baie Chaleur. In connection with the Devonian of southern New Brunswick are volcanic rocks; sections of some near Point Lepreau show them to be ordinary quartz porphyries of no special interest.

Again, in the sub-Carboniferous period we find that a large amount of volcanic outpourings took place at various points along the southern margin of the central plain, and volcanic rocks appear from under the eroded millstone grit rocks at Grand Lake, within this plain. The Blue Mountains, north of the Tobique River, consist of effusive rock referred to this period. These sub-Carboniferous volcanics are felsites and traps, and have not been studied with the microscope.

Throughout the Middle and Upper Carboniferous and the Permian periods there is no trace of any volcanic activity, but the small areas of Triassic rocks occurring in New Brunswick, are associated with heavy trap dykes, and about half of the island of Grand Manan is composed of Triassic trap.

The periods of volcanic activity in New Brunswick are, then:

1. *Huronian* — Southern New Brunswick and the northern watershed.
2. *Silurian* and *Early Devonian* — Passamaquoddy Bay, Baie Chaleur, etc.
3. *Sub-Carboniferous* — borders of the central plain, Grand Lake, Blue Mountains of the Tobique.
4. *Triassic* — Quaco, Grand Manan.

In Nova Scotia the volcanic rocks are not less important than in New Brunswick. In Cape Breton is a great development of pre-Cambrian rocks, which appear from the reports to be chiefly igneous; and considerable areas occur in Pictou county, and in the range of hills north of the Basin of Minas. A large amount of volcanic material of later age also occurs in the north-eastern part of the peninsula. From Dr. Fletcher's reports it would appear that the volcanic periods were about the same as in New Brunswick, with the addition of the Ordovician.

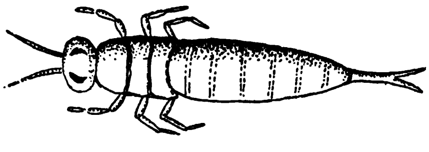
The Triassic traps forming the North Mountains of Nova Scotia, lying all along the southern side of the Bay of Fundy, are well known. Besides the main area there are small detached ones in the Basin of Minas. These rocks are often amygdaloidal and have a wide fame as mineral localities. The rock has been examined by Prof. V. F. Marsters and is a normal diabase, very uniform in character and very like the Triassic traps of the eastern United States.

Prince Edward's Island affords no volcanic rocks.

In Newfoundland the conditions were much like those of Nova Scotia and New Brunswick. The Laurentian rocks are capped by a series, in large part volcanic. (Of the extent of later volcanics I cannot speak certainly, it is probably much the same as in Nova Scotia.)

So far, little note has been made of the intrusive granites which form so important a feature of New Brunswick and Nova Scotian geology. The main areas of these rocks in New Brunswick are considered to be of Devonian age; they are found cutting through and metamorphosing Silurian strata, while as pebbles they first appear in the conglomerates of sub-Carboniferous age. Two great bands cross the province, the one coming in from Maine north of the head of Passamaquoddy Bay, and running north-east nearly to the St. John River; the other entering at the Chiputucticook Lakes at the head of the St. Croix River, and stretching in a number of interrupted bands nearly to the shores of Baie Chaleur. A great area flanked on each side by metamorphic slates of doubtful age, through which it has thrust itself, stretches from end to end of the Nova Scotian peninsula. Other small isolated areas are known in both provinces, but none at all comparable in size to those mentioned. These granites seem to have come to the surface during the great upturning that closed the Devonian in the Maritime Provinces, and which metamorphosed and tilted to a greater or less extent all the pre-Carboniferous strata.

The Maritime Provinces affords a great field for petrographic study of igneous rocks and one in which little has been done. The question as to the individual succession of the different kinds of rocks in each volcanic period, their centres of distribution, and the connection of the surface volcanics with the intrusive masses are as yet almost untouched, and although the unsettled and wooded character of much of the region would hinder the working out of these problems, yet a careful study would no doubt be well repaid. It is to be hoped that much will yet be done in this almost untrodden field.



PODURITES SALTATOR.

A fossil insect (Springtail) of the Little River Group—magnified and restored.

APPENDIX.

REPORT ON THE SUMMER CAMP AT FRENCH LAKE.

(Held August, 1893.)

The principal object of the visit to this district was the study of the remains of the Stone age, which from information we had known were to be found there. August was chosen as the best time to visit this lake, as during this month the St. John river is usually at its lowest stage, and the shallows along the shores are then above the surface of the water, or near to it.

TOPOGRAPHY AND GEOLOGICAL CONDITIONS.

French Lake is the uppermost of three considerable sheets of water that lie in the lowest part of the central plain of New Brunswick. These lakes are not individually in direct connection with the St. John river at the ordinary stage of that stream; for while the river traverses this depressed part of the central plain in which the lakes are situated, it has built up for itself on each side, banks of alluvium, which bound its channel, and shut it off from the lakes.

As a consequence, the outlet of the lakes is by a narrow, deep channel (the Jemseg) which enters the St. John several miles below the last of the chain of lakes (Grand Lake). Similar deep passages, locally called "thoroughfares," connect the middle lake (Maquapit) which the other two.

The current is not always downward through these passages, for when the river St. John rises, owing to rains in the upper valleys of that stream, the water runs backward in the thoroughfares, and the lakes become reservoirs for the storage of the surplus waters of the river. The thoroughfares being the only means of connection between the lakes, and with the river at its ordinary stage, and as also giving access to the numerous creeks and shallows around the lakes, swarm with fish at certain seasons of the year. In former years, these passages were black with gaspereaux and shad, pressing forward into the lakes to spawn in the shallows, and even now fish abound in them.

A people capable of taking these fish by spear, net or line, would find an easy means of subsistence on the shores of these creeks and thoroughfares; and at the more commanding spots one might naturally look for indications of occupancy by a rude people. Such indications are not wanting, but they did not occur in the way anticipated from the exploration of village sites along the Bay of Fundy. There, when the sites were undisturbed by the plow, one had no difficulty in seeing the situation and extent of the village, nor in tracing the outlines of each particular hut-bottom, nor noting the place of the sleeping berths, the position of the door, nor in counting, if necessary, the hearth stones.

But on the shores of these inland sheets of water, no such evidence of the habits of the former savage inhabitants could be found. At the points of land along the shores of the lakes, at the entrances of the thoroughfares, or where creeks led into ponds in the marshes, no hut-bottoms were found, but proofs of the presence of man were frequent in the shape of broken pottery, flint flakes, or lost celts, arrowheads and axes. It was evident that the people who lived along these shores had means of traversing the water by canoes or otherwise, and planted their habitations where water communication was easy, and fish plentiful. But it is also clear that their shelters were of a temporary kind, and built near the water's edge.

Their mode of life in this way along the banks of the streams, explains why we find not the least trace of their habitations. These lakes, with their connecting streams and marshy borders, disappear in the spring time, for the flood of water poured out by the great tributaries of the St. John submerge all this region, and produce for the time a great inland lake extending up the valley of the St. John to Fredericton on the one hand, and the Oromocto valley on the other, covering ing about six hundred square miles of surface. It may rise above the summer level to a height of twenty feet or more, and with a wide range for the waves, would, in stormy weather, throw a surf on the shores that would soon demolish the dwellings of a rude people, and mingle even their more enduring implements and weapons, left or lost on the site of their encampment, with the pebbles and sand of the beach. Such, no doubt, was the fate of many an implement which otherwise would have remained on the surface of the ground to the present day, to bear witness to avocations of the fisherman and the hunter, pursued during the Stone age along these grass-grown shores.

These lake basins date back as far as the time of the deposition of the Champlain clays or Leda clay; and the material of the clays is that with which we are familiar as stock for the manufacture of our bricks. A cursory glance at the map of New Brunswick would lead us to think that these lake basins were produced by the building up in their front of the alluvial deposit of the St. John; but a more intimate knowledge of their shores shows that they and the banks of the thoroughfares are to a large extent composed of Leda clay.

Furthermore, it would appear, that if a subsidence of this region is in progress, it is very slow indeed. The south-west shore of Maquapit Lake illustrates this point very clearly; for this lake is now encroaching on its low clay shores, uprooting the vegetation along its banks, and exposing in its submerged mud-flats, the roots of the former forest; these roots and their rootlets are now cased in ferrugenous pipes, hardened in the surrounding clay.

A curious relic or fragment of a former thoroughfare along the southern side of this lake is found in "Ring Creek," a semicircular channel which has no break in its bank toward the side of the river, but has shallow outlets, at each end, to the lake. The channel of the creek within the flats at the two outlets is deep, but without any current at the present time. This demolished thoroughfare is proof of a decided encroachment of the lake upon its shores at the southern side. A similar condition of things appears to prevail along the south-west shore of Grand Lake, as flint-flakes have been found on the flats there, but no investigation was made by our party. On the shallow mud-flats on this side, both of Maquapit and Grand Lake, "flint" flakes and implements have been found; on the former lake as much as a furlong from the shore.

The facts observed indicates a very slow and gradual sinking of the land in this region, leaving the stone relics on the mud and sand at the bottom of the advancing lake; it thus encroached upon the yielding shores, and removed what traces there might be, of aboriginal camping sites.

Leading from Maquapit into French Lake are two thoroughfares of which that nearest the river is bordered by high banks of alluvium, and only at the ends shows exposed banks of Leda clay. The other thoroughfare, which is shallow, is known as the Blind thoroughfare, and shows banks of Leda clay all along its winding course.

The whole country around these lakes is of gently undulating land, diversified with low rounded hills of Boulder clay and with a few gravel ridges. Over the Boulder clay is spread a thick coating of Leda clay of a grey color, from which are washed great numbers of pellets of iron ore, which form layers as of sand along the shores of the lakes.

We have called the clay which bordered and underlies these lake basins, Leda clay, because it holds the same relation to the Boulder clay below, and the alluvial deposit of the river above, as the red Leda clay of the valleys at the coast holds to corresponding deposits along the Bay of Fundy. It should be said, however, that no trace of marine shells has been found in this clay; and it is quite possible that the basin in which the clay was deposited may have had no free communication with the ocean.

This visit to French Lake disabused us of a notion as to the relative stage of culture of the men who lived on the river, and those who inhabited the shores of the Bay of Fundy. Previously we had been inclined to allow a possible difference in the degree of artistic finish of their weapons, by the men of the Stone age occupying these districts, respectively.

Such a distinction has been claimed between the men who left the kitchen-middens on the coast of Denmark, and those who formed the tumuli of that country, and lived in its interior. It is quite evident, however, that such a distinction does not hold for the Stone-age men of the St. John river and the Bay of Fundy coast respectively, as many of the weapons gathered on the shores of the lakes which we examined, were quite as rude as those found at Bocabec.

The difference which has existed in this respect between the collections made on the river St. John and those gathered from the shell heaps on the Bay of Fundy, appears to be due to the fact that around the lakes only the tools and weapons which possessed a good finish were recognized as works of art, and collected by the ordinary observer, and the coarser implements were entirely overlooked. This is quite natural, if we observe how difficult it is to distingnish some of these rude tools from ordinary boulders and stones—such were many of the celts, hammers and scrapers which we collected.

The flaked implements showed in many cases considerable nicety of finish, and were of several patterns. The spear heads were of two principal types, one a heavy head for a stout spear, the other having a slender point, and being similar to forms which have been thought to be points of fish spears.

The arrowheads were very variable in size, and were barbed or tined, or wedged-formed at the base.

We found two types of skin scrapers which are new to the New Brunswick collections: one is of a triangular form, the pointed end of the triangle being for insertion in a handle; the second form was oblong with a rounded back and apparently equally well finished at either end; this may have been intended for use without a handle. A novel implement found here which may have been a scraper to hold in the hand, was of the form of an ordinary bivalve shell with a bulbous swelling on each side corresponding to the umbones of such a shell. The wood scrapers were not of so definite a form as those found at Bocabec, nor did they so frequently show proofs of use as scrapers.

Knives and knife-flakes were common, and did not show unusual forms, except one scymitre-shaped example, and one larger and coarser than usual, having chipped edges.

Among the relics found there were a few axes fitted for mounting in with handles and one small war axe. Celts were numerous, but many were of the rudest kind, and evidently were boulders of suitable form which could be adapted for use with very little preparatory chipping or grinding.

At this camp eighteen persons were present, and instruction was given in archology, geology, botany and microscopy. The camp was under the management of the Secretary of the Society —S. W. Kain—and the instructors were G. F. Matthew, W. D. Matthew, and Frank Berton.

The members were greatly indebted to the late J. S. Jewett of Lakeville Corner, and his family, who extended their hospitality to the members of the Society on their arrival, and aided them in many ways during their stay. It was through Mr. Jewett's instrumentality that a public hall was placed at the disposal of the Society for lectures and class work.—G. F. M.

REPORT ON THE SUMMER CAMP AT LEPREAU BASIN.

(Held July 1895).

The neighborhood of Lepreau Basin affords excellent opportunities for the study of botany, marine zoology and geology, and for this reason, as well as for the unusual facilities for laboratory work and lodgings afforded to the Society through the liberality of G. K. Hanson, Esq., Collector of Customs at Lepreau, was chosen by the Council for the exploratory work of this summer. This place is accessible by means of the Shore Line Railway to Lepreau Station, whence a drive by stage of about four miles brings one to the shores of the Basin.

Lepreau Basin is a land-locked sheet of water, closed in from the sea by a gravel beach and low cliffs of sandstone. At low tide there are extensive sand flats in the basin, which are traversed by interrupted creeks and ponds, affording a refuge to the marine animals which the rising tide bring into the basin. Outside of the basin, also, on the shore of Mace's Bay, the ledges of sandstone, laid bare at low tide, afford opportunities to collect other species, which are rare in the enclosed waters of the basin.

The headquarters of the camp were in a vacant house on a mining property owned by Mr. Hanson, near the shore of the basin. A large room served for a lecture and demonstration room, and the rest of the house gave ample accommodation for the party of members who attended the camp.

The building we used had been put up by a mining company which undertook to operate on the beds of coal which are found in the Dadoxylon sandstone. The earliest work on these beds was undertaken by Mr. Hanson at his boat landing, on the shore of the basin, where two seams appear. The company referred to above, after operating on the northernmost of these seams, transferred their works to where the seam is exposed at the edge of the bank, one hundred yards or more to the westward. Not being satisfied with the position of the pit, which, being near the shore, was subject to a heavy flow of water, the company undertook to sink a new shaft some distance back from the bank, with the intention of drifting south to the coal seam. This shaft was entirely in the red shales of the Mispec group, which are here let in behind the sandstones of the Little River group by a fault. The sinking of this shaft, the cost of new buildings, and other expenses which were incurred, crippled the company financially, so that they were unable to carry their work further, and their buildings and property have reverted to Mr. Hanson, the original owner and one of the stockholders.

Operations on these seams have been undertaken at the middle and at the eastern end of the basin by other lessees, but as these mines are beyond the limit of the district examined by our party, it is not necessary further to refer to them.

Beside the tract immediately around Lepreau Basin, our party spent a day in visiting Point Lepreau, which lies some miles to the south of the basin. In some respects very little was gained from this visit, but the members had a good opportunity of seeing the picturesque cliffs and shores around this Point and of inspecting the lighthouse at its extremity. No traces of aboriginal camping-grounds were found on the beaches, either east or west of the point. Professor Ganong found reason to think the shores around this point would prove an excellent collecting ground for those in search of marine animals and plants.

THE WORD "LEPREAU."

Prof. W. F. Ganong has sent the following note respecting the origin of this word:

'The ultimate origin not known with certainty; but doubtless it is French of same period with "L'Etang," etc. But our word is unquestionably a lineal descendant of the Point *la Proe* of the English maps of the early part of the last century — those of Southack and others, and it can be traced all through maps of ths last century. Our Lepreau may be only an effort to restore the French form. Upon grounds both historical and philological the word should be "Lepreau" and not "Lepreaux." If the "x" is put at the end it should be written "Lespreaux," but there is no historical basis for this. I therefore think "Lepreau" should be the form used.

'Modern dictionaries give "Preau" as meaning a flat or mea dow, which is not very appropriate to the place, and we are not sure that it was the original word. Another puzzle about it is that certain French maps of 1744–55 have "Napreaux"; but earlier English ones call it "la Proe." I cannot find any meaning for the word "Napreaux," and it is possibly a misprint for something else — misprints are very common on old maps. The "x" may have some significance in explaining where the "x" in our form Lepreaux came from.'

TOPOGRAPHY.

The district where we spent our week consists of two essentially different tracts of land separated by the main arm and outer part of Lepreau Basin.

To the north of the basin is a low lying tract extending northward to Lepreau harbor and river, diversified with alternations of heath covered clay flats, low rocky ridges with gravelly slopes clothed with straggling forest and copses; and in the wettest parts peat bogs of considerable extent.

To the south of the basin the land is higher and carries on its higher ridges tracts of hardwood forest, and on the slope toward Mace's Bay has a range of farms in a good state of cultivation, extending nearly to Point Lepreau.

Around Lepreau Basin itself there are clay flats where the soil has been turned into meadow land, but these are of no great extent.

GEOLOGICAL STRUCTURE.

The topographical features of this peninsula are clearly traceable to its geological conditions in past time. Running through it in a north-east direction are two axes of Laurentian rocks; one near Lepreau River, consisting of quartz-diorites and gneissic rocks; the other lying to the south of the main arm of Lepreau Basin, consisting of quartzites and limestones of the "upper series" of the Laurentian area.

Between these axes is a narrow basin extending through to the Musquash River, filled with sediments of the Little River and the Mispec groups, which have been crushed together and thrown into a number of broken synclinal, anticlinal and monoclinal folds. The great dislocations which these beds have suffered makes it difficult to trace their structure, and has detracted from the commercial value of the coal beds which they contain, and which are of exceeding interest to the naturalist on account of their unrivalled antiquity.

Resting upon both the old Laurentian sediments, and these later ones of the Little River and Mispec groups, is a series of conglomerates and sandstones, skirting the eastern shore of Mace's Bay, and extending around Point Lepreau toward Dipper Harbor. Mace's Bay is largely underlain by this series of rocks, which rises to view in Salkeld's Islands, and when the tide is low is seen to extend in wide reefs, miles away from the shore.

Owing to the calcareous cement binding these sandstones and and conglomerates together, which dissolve on exposure to the rain and weather, they waste away rapidly at the high tide line, and form a line of low cliffs facing Mace's Bay; and to the easy solution of this same calcareous cement is largely due the fertility of the farms constituting the thriving settlement along this shore.

From the attitude of the slates and sandstones of Lepreau Basin, the history of some of the dynamical movements which have affected the rocks of this district may be inferred. Thus, on the line of the main arm of Lepreau Basin there is a narrow strip of the lower carboniferous conglomerates and sandstones that has been let down among the Little River and Mispec sediments, and is boundedby sharply defined fault lines. So also on the Lepreau harbor, on the north side of the peninsula, there is a narrow belt of these same sandstones and conglomerates, lying between the rocks of the northern axis of Laurentian, and the schist and diorites on the north side of Lepreau Harbor.

The bands of softer unaltered rocks among the older sediments and igneous rocks, appear to have determined the place of these two harbors, and so the main lines of depression of this peninsula area. Not that this condition of depression is entirely due to the softer texture of the later rocks, but there is little doubt that the lines of weakness and faulting that have been determined where these strips of the more recent sediments are let in, have continued to be lines of weakness and faulting in later ages.

The history of geological events in this district may be summarized as follows:

1. The oldest recognizable deposits are the quartzites and limestones of the "upper series" of the Laurentian area, which appear in the hills south of the basin.
2. A great break in the succession of beds then follows. This includes the time when the Coldbrook (Huronian?) and St. John groups were deposited, and so extends from pre-Cambrian to early Ordovician time both included. It also includes the later Ordovician, which appears to have been a time of continental elevation in New England and Acadia.
3. Second period of sedimentation. At this time the Little River group was deposited.
4. Folding of this group with heavy erosion, exposing the limestones and quartzites of the Laurentian.
5. Another period of sedimentation during which the Mispec group was deposited.
6. Third period of erosion, with folding and faulting of the beds, exposing again the Laurentian rocks. Great lateral pressure and partial metamorphism of all the older terrains accompanied these changes.
7. Another period of sedimentation, during which the Lower Carboniferous terrain was laid down.
8. This terrain also was uplifted and folded, but the subsequent geological changes are not exemplified by any deposits in this district until the Glacial epoch.

The organic remains collected from the sandstones, etc., at Lepreau will form the subject of a future communication.

—G. F. M.

ZOOLOGY.

The zoological results were mostly negative. Owing to the shortness of time the camp was in session, unfavorable weather and difficulty of obtaining a proper boat, no dredging was done, and exploration was confined to walks along the shore at low tide. The fauna is the usual beach fauna characteristic of this region, and nothing was observed to differentiate it from the well-known assemblage of animals about Frye's Island. It was hoped that in Lepreau basin, sheltered as it is, traces would be found of the southern forms which linger in small colonies in sheltered spots on the shores of Acadia, and traces of which have been found on the St. Croix River. But although some search was made no trace of them was found. Lepreau Basin itself is disappointing, for it is rather barren of any forms except the economic clam; at all events this is true of mollusca and echinoderms, the two test-groups of our fauna. Star-fishes and even sea-urchins occur there hardly at all; a fact due, no doubt, to the long time the basin is empty at each tide and consequent warming of water in the pools. Much was expected also from the excursion to Point Lepreau itself, but the tides were neap and on our arrival an hour flood. But enough was seen in the tide-pools to show that this is a most promising locality, and it is earnestly commended to the attention of those members of the Society who may have opportunity to visit it. Mace's Ledges were also found extremely barren of animal life, and the forms found were of the commonest.

Visits were made to Clear Lake, a remarkable basin not much more than a quarter of a mile long, and without inlet. Locally reputed to be bottomless, an extreme depth of seventy-eight feet was found, after thorough soundings; but this is a great depth for so small a lake. On both sides of the lake are ledges belonging to the Dadoxylon sandstone, and the lake seems to occupy a gorge in them. Interesting water plants grow in the lake, including *Eriocaulon septangulare*, growing at a depth of nine feet. There are interesting biological problems connected with this plant, particularly as to how it obtains the oxygen needed in the development of its enormously long flower stalks.

The camping party spent about ten days at Lepreau Basin. The instructors were Professors W. F. Ganong and L. W. Bailey, Principal G. U. Hay and Dr. G. F. Matthew. Lectures were given in the evening on zoology, botany and geology, with excursions and class-work during the day.—W. F. G.

REPORT ON GEOLOGY.

It may be of interest to the members of this Society to know that the Cambrian rocks of St. John have yielded several brachipods, which have thrown considerable light on the early history of this great class of the mollusca; a group of much greater importance in past time than now: but of which, nevertheless, several very ancient types have subsisted until the present time.

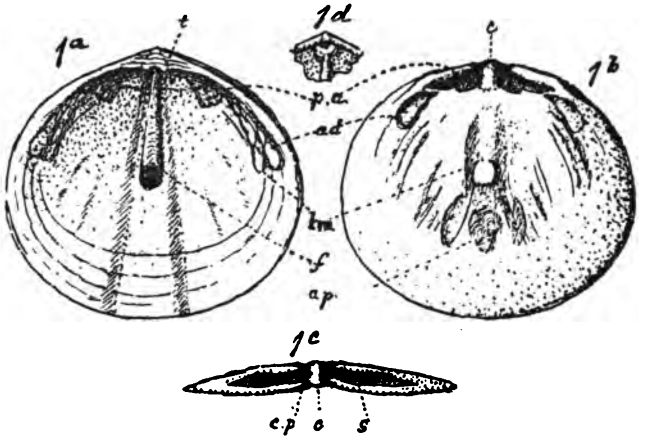
The progress which has been made of late years in the knowledge of this ancient group, has led to the suggestion of several systems of classification, looking to the incorporation of this new knowledge.

One of the latest systems of classification is that proposed by Prof. Chas. E. Beecher, which has been amplified and extended by Chas. Schuchert, and illustrated by Prof. J. M. Clarke and Miss Agnes Crane. In this system the position of the opening or passage for the byssus or thread, by which the shell was anchored, is taken as of primary importance in classification.* Thus there are the (1) ATREMATA, in which there is no passage through the shell for the byssus, or merely a groove in the edge of one of the valves. (2) The NEOTREMATA in which the shell may have a perforation at various distances, from the back of the valve along the central line. (3) The PROTREMATA, in which there is a slit at the back, more or less completely closed by a plate. (4) The TELEOTREMATA, which belong to a period later than the Cambriam, and in which the "arms" within the shell have a calcareous support.

Some primitive and therefore, to the naturalist, highly interteresting examples of genera of the first three orders are found in the Cambrian rocks at St. John, among which may be named for the first order, *Botsfordia pulchra* (Matt.), the young of which have the form of the most primitive type of Brachiopod known; for the second order *Trematobolus insignis* (Matt.), (figured below), which unites the general characteristics of the first order with the perforated valve of the second and the articulating hinge of the third; for the third order, *Protorthis Billingsi* (Hartt), remarkable for the broad low opening in the valves, and its resemblance to the genus Orthis of later Cambrian time.

*** The value of this character in the classification of the Brachiopoda was urged a good many years ago by Prof. Jas. Hall of Albany.**

Fuller accounts of these and other genera of the St. John Group may be seen in the transactions of the Royal Society of Canada, in Genera of the Brachiopoda, by Jas. Hall and J. M. Clarke,* and in the Protolenus Fauna.†



TREMATOBOLUS INSIGNIS.

a. Interior of the ventral valve. *b*. Interior of the dorsal valve. *c*. Dorsal valve seen from behind. *d*. Inside of beak of ventral valve. *Notation of the muscles, etc.* *p. a*. Posterior adductor. *a. d*. Adjuster muscles. *l. m*. Lateral muscles. *a. p*. Anterior depression. *c. p*. Cardinal pit. *c*. Cardinal process. *s*. Hinge socket. *t*. Dentiform process of the ventral valve. *f*. Foramen. From Assize 2. Band *b*, Div. 1, St John Group at Hanford Brook, St. John County, N. B.

—G. F. M.

BOTANICAL REPORT.

The Botanical Committee report the occurrence of the following plants :

Plantago maritima, Lepreau (Hay) ; Gilia linearis, Gray, Lepreau (Roy Vanwart and Geo. W. Bailey) ; Lathyrus pratensis, L. Ledge, St. Stephen (F. A. Pickett) ; Comandra livida, Richardson, Lepreau ; Ralfsia deusta, an addition to our Algoid flora, on rocks at low water. Entrance of Lepreau basin (W. F. Ganong). Some notes upon the plants of the peat bogs will be communicated at a future time by Prof. W. F. Ganong.

—G. U. H.

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* Published by the State of New York, Albany.

† Published by New York Academy of Sciences, New York.

BIBLIOGRAPHY OF SCIENTIFIC PUBLICATIONS RELATING TO THE PROVINCE OF NEW BRUNSWICK OTHER THAN THOSE CONTAINED IN THE BULLETINS OF THE SOCIETY, 1890–1895.

BY SAMUEL W. KAIN.

It is proposed to publish each year in the Bulletin the titles of all works other than those contained in the Bulletins themselves relating to New Brunswick, in the subjects coming within the scope of the Society's work.

General works, merely with occasional references to New Brunswick, will not be included, but only such as relate specifically to the natural history of New Brunswick, or contain chapters or sections devoted specifically to it, or which contain results of studies carried on in New Brunswick or upon materials obtained in the province.

The multiplication of scientific publications makes it impossible for any, except specialists, and difficult for them, to keep track of scientific literature; hence for those interested in a more general way, as well as for the use of coming students, it is desirable to have placed permanently on record all obtainable titles.

It has been thought advisable to begin with the year 1890 and bring it up to present date, but in future to give only those of the year with any omissions from previous lists. Members and correspondents are earnestly requested to aid in making these lists complete.

GEOLOGY.

BAILEY, L. W.—The Gold-bearing Rocks of New Brunswick, and the Possible Discovery of Remunerative Gold Deposits. *Trans Royal Society of Canada, Vol. IX, sec. iv, pp.* 21–27. 1891.

On the Mineral Resources of New Brunswick. *Canadian Mining and Mechanical Review.* 1891.

CHALMERS, ROBERT.—Report on the Surface Geology of Eastern New Brunswick, North-western Nova Scotia, and a portion of Prince Edward Island. (In press).

Annual Report. Geological Survey of Canada, Vol. VII, (N. S.), Part M., pp. 149. With three maps. 1895.

ELLS, R. W.—The Geology of the Proposed Tunnel under the Northumberland Strait. *Trans. Royal Society of Canada, Vol. XI, Sec. IV, pp.* 75–81. 1893.

GOODWIN, W. L.—Reclaiming Bog in Westmorland County, N. B. *Can. Record of Science, V- p.* 364. 1893.

MATTHEW, GEO. F.—On Cambrian Organisms in Acadia. *Trans. Royal Society of Canada. VII, Sec.* 4, *pp.* 135–163, 5 plates, 3 cuts. 1890.

On Some Causes which have Influenced the Spread of the Cambrian Faunas. *Canadian Record of Science, Vol. IV, pp.* 255–269. *Jan.* 1891.

Illustrations of the Fauna of the St. John Group. *No. V. Trans. Royal Society of Canada. VIII, Sec.* 4, *pp.* 123–169. 6 plates, 3 cuts. 1891.

On a New Horizon in the St. John Group. *Canadian Record of Science, Vol. IV, pp.* 339–343. *Oct.* 1891.

Notes on Cambrian Faunas. I, The Taconic Fauna of Emmons compared with the Cambrian Horizons of the St. John Group. *American Geologist, Nov.* 1891, *pp.* 287–291.

Note on Leptoplastus. *Canadian Record of Science, pp.* 461–462. *Dec.* 1891.

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Trematobolus, an Articulate Brachiopod of the Inarticulate Order. *Canadian Record of Science, pp.* 276–279. *January,* 1893.

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Post-Glacial Faults at St. John, N. B. *American Journal of Science, XLVIII, pp.* 501–503. *Dec.* 1894. 1 *plate.*

On the Organic Remains of the Little River Group. *Nos.* 2 and 3. *Trans. Royal Society of Canada. Vol. XII, Sec.* 4, *pp.* 89–112. 1 plate. 1895.

The Protolenus Fauna. *Trans. New York Academy of Sciences. Vol. XIV, pp.* 101–153. 11 plates. 1895.

MATTHEW, WM. D.—On Phosphate Nodules from the Cambrian of Southern New Brunswick. *Trans. New York Academy of Sciences. Vol. XII, p.* 108. 1893.

The Intrusive Rocks near St. John, New Brunswick. *Trans. New York Academy of Sciences. Vol. XIII, p.* 185, *pl. V.* 1894.

The Effusive and Dyke Rocks near St. John, N. B. *Trans. New York Academy of Sciences: Vol. XIV, p.* 187, *pl. XII–XVII.* 1895.

PHYSIOGRAPHY.

BAILEY, J. W.—The Saint John River in Maine, Quebec, and New Brunswick. Cambridge, Mass. 1894. 178 *pp. Map.* (An excellent popular work).

EATON, FRANK H.—The Bay of Fundy Tides and Marshes. *Popular Science Monthly, Vol. XLIII. No. 2, pp.* 250–256. *June* 1893.

KOBBÉ, GUSTAV.—The Tides of the Bay of Fundy. *Scribner's Mag. XIV, p.* 335–343. 1893.

MURDOCH, WM.—Why Ice in the Kennebeccasis Expands in a North-westerly Direction. *St. John Globe. March* 10, 1894.

RECLUS, ELISEÉ.—Physical Features, etc., of New Brunswick. *The Universal Geography, Vol. XV, pp.* 339–367, 1893. (?)

BOTANY.

GANONG, W. F.—On Raised Peat-bogs in New Brunswick. *Botanical Gazette, XVI, pp.* 123–126, *May* 1891.

HAY, GEO. U.—The Flora of New Brunswick. *Trans Royal Society of Canada, XI, Sec.* 4., *pp.* 45–50. 1893.

Native Trees and Shrubs. *Educational Review, April* 1891.

Perkins, H. F.—The Flora of Blissville. *St. John Gazette, March* 8th, 1894.

Preliminary List of Plants found growing on Grand Manan. *St. Croix Courier. Jan.* 31, 1895.

ZOOLOGY.

Allen, J. A.—Notes on Mammals from New Brunswick, with description of a New Species of Evotomys. *Bull. Am. Mus. Nat. Hist. VI, pp.* 99–106. 1894.

On the Seasonal Change of Color in the Varying Hare *(Lepus Americanus) Ibid., pp.* 107–128.

Remarks on a Second Collection of Mammals from New Brunswick. *Ibid., pp.* 359–362.

Bailey, Prof. L. W.—A New Snake Find. (Note on *Storeria occipito-maculata.*) *Educational Review, Dec.,* 1890.

Fewkes, J. **Walter**.—On Excavations made in Rocks by Sea-urchins. *American Naturalist, XXIV. pp.* 1–21. 1890.

A Zoological Reconnoissance in Grand Manan. *Ibid., XXIV, pp.* 423–435. 1890.

Ganong, W. F.—Southern Invertebrates on the Shores of Acadia. *Trans. Royal Society of Canada, Vol. VIII, Sec. IV, pp.* 167–185. 1890.

Miller, G. S.—Description of a New Jumping Mouse from Nova Scotia and New Brunswick, *Am. Naturalist, XXIII, pp.* 742–743. *Aug.,* 1891.

Description of a new White-footed Mouse from the Eastern United States. *Proc. Biological Society of Washington, VIII. pp.* 55–70. 1893. (The mouse also from N. B.)

Prince, E. E.—A Morning among Moose. *Ottawa Naturalist, Vol. XI, No.* 5, *pp.* 103–107. 1895.

ETHNOLOGY.

Adney, **Tappan**.—Milicete Natural History. *Proc. Lin. Soc., New York, No.* 5, *pp.* 19–38. 1893. (Maliseet names of the common birds and mammals, with comments).

FEWKES, J. WALTER—The Use of the Phonograph in the Study of the Languages of the American Indians. *American Naturalist, XXIV, pp.* 495–476, 1890.

Contributions to Passamaquoddy Folk-Lore. *American Journal Folk-Lore, pp.* 24, *plate. Dec.* 1890.

GOODWIN, W. L.—Notes on an old Indian Encampment. *Can. Record of Science, Jan,* 1893.

JACK, EDWARD.—The Abenakis of Saint John River. *Trans. Canadian Institute, Vol. III,* 1891–2, *pp.* 195–205, *Toronto.* 1893.

Maliseet Legends. *Journal American Folk-Lore, VIII. pp.* 193–208. *Sept.* 1895.

THE TIDE GAUGE AT ST. JOHN, N. B.

In 1892 the Dominion Government erected a tide gauge at St. John. Gauges have also been erected at St. Paul Island, Belleisle, Father Point, South-west Point (Anticosti) and Halifax.

The gauge column at St. John is situated in the south-east corner of the Reed's Point Wharf (latitude N. 45° 17′, longitude W. 66° 4′). The timber shaft contains two tubes, one of which is used for the eye observation gauge, and the other for the Sir Wm. Thompson self-recording gauge.

It is proposed to operate this gauge for nineteen years (a lunar cycle). A bench-mark has been cut on the south-east corner of the Custom House. The clock plate of the self-recording gauge is 36·95 feet above zero on the eye observation gauge, and 23·03 feet below the bench-mark on the Custom House.

The establishment of the St. John gauge is of interest to geologists, as observations for a series of years would provide data for detection of earth movements.—S. W. K.

NOTE.—For further information see Proceedings Royal Society of Canada, Vol. VIII, pp. viii-ix, 1890; Vol. X, pp. ix-x, 1892. Reports of Marine Department 1891, 1892, and 1893.

THIRTY-THIRD ANNUAL REPORT

OF THE

COUNCIL OF THE NATURAL HISTORY SOCIETY

OF NEW BRUNSWICK.

The Council of the Natural History Society desires to lay before the members its annual report on the work for the year now ending:

MEMBERSHIP.

The following additions have been made to the roll of members:

Honorary (Monsig'r J. C. K. Laflamme),	1
Life (Prof. William F. Ganong),	1
Corresponding,	3
Ordinary,	9
Associate,	14
Total,	28

During the year, three of our members have been removed by death.

Geo. F. Smith, Esq., died March 6th, 1894. He was a member for many years, and by his death the Society lost a valued member.

Gilbert Murdoch, C. E., died May 28th, 1894. He was one of the founders of the Society, and in former years contributed some valuable papers. His paper on Meteorology, embracing observations at St. John from 1850 to 1862, was published in 1863, and is a most valuable record.

Mr. H. W. Northrup died June 18th, 1894. He had only been a member for a short time, but was much interested in our work.

FINANCE.

The Treasurer's report shows the following receipts and expenditures:

Balance from last year,	$ 14 79
Dues collected,	107 00
Bulletins sold,	4 05
Government Grant,	125 00
Interest on Investment,	144 00
Other items,	45 50
	$440 34
Current Expenses,	388 03
Balance,	$52 31

LECTURES AND ESSAYS.

During the year, twelve meetings of the Society were held, at which the following papers were read:

1894.

Feb. 6. Fish Life in the Upper Waters of the River St. John. By Wm. M. McLean, M. A.

The Ingratitude of Societies. By Samuel W. Kain.

Mar. 6. (1) Report on the North-westerly Expansion of Ice in the River Kennebeccasis. By Wm. Murdoch, Esq., C. E. (Published in *Globe*, March 10th, 1894.

(2) Dr. Silas T. Rand, Missionary, Linguist, and Author. By Miss Eleanor Robinson.

(3) Botany of the Parish of Blissville, Sunbury County, N. B. By Henry F. Perkins. (Published in *Gazette*, March 8th, 1894.

(4) The Intellectual Pre-eminence of the Germans. By William F. Ganong. (Published in *Educational Review*, March 1894.

April 3. (1) Spring Birds at Petitcodiac—with table showing date of arrivals and departures for five years. By John Brittain.

(2) Bacteria. By W. F. Best.

April 10. A New Re-agent in Blowpipe Analysis. By Prof. W. W. Andrews.

May 1. An Outline of Phytobiology (1st Paper) By W. F. Ganong. (Published in Bulletin XII.)

June 5. (1) Report of Delegate to Royal Society of Canada. By Geo. U. Hay.

(2) Address on the Work of the Experimental Farms. By John Craig, Esq.

(3) The Crystalline Rocks around St. John. By W. D. Matthew. (Published in Bulletin XII.)

(4) Notes on the Botany of the Valley of the Upper St. John. By Merritt Lyndon Fernald. (Read by title.)

Oct. 2. The Mosses of New Brunswick, with a Description of some New Species. By John Moser.

Oct. 9. Some Evidences of a Glacial Epoch. By Charles R. Fisher, Esq. (Published in Bulletin XII).

Nov. 6. Post-Glacial Faulting at St. John. By Dr. Geo. F. Matthew. (Published in Bulletin XII.)

Nov. 13. Outlets of the St. John River. By Dr. Geo. F. Matthew. (Published in Bulletin XII.)

Dec. 4. Recent Plant-studies and Discoveries in New Brunswick. By Geo. U. Hay, M. A.

1895.

Jan. 2. The Mountain Systems of America—A Comparative Study. By Dr. L. W. Bailey. (Synopsis published in Bulletin XII.)

As in former years, a course of elementary lectures in science has been given. It proved of great interest, and was as follows:

PALÆONTOLOGY.

Lecturer, Geo. F. Matthew, D.Sc., F.R.S.C.

Jan. 9. Scope and Purpose of the Science.

23. Trilobites of the St. John rocks.

30. Fossil Botany of the Palæozoic Rocks, with special reference to the coal measures and plant bearing beds at St. John.

BACTERIA.

Lecturer, W. F. Best, Esq.

Feb. 13. Historical Sketch of Subject, etc.

20. Fermentation and Yeasts.

27. Bacteria of the Mouth, etc.

BIRDS.

Lecturer, Philip Cox, B.Sc. Ph.D.

Mar. 13. Organization of Birds in Relation to their Habits.
20. Plan of Birds in the Economy of Nature.
27. Intelligence of Birds, inherited and acquired.

PLANTS.

Lecturer, Geo. U. Hay, M.A., F.R.S.C.

April 10. The Plant as a Living Being, etc.
17. Flowerless Plants, Structure, Classification, Uses.
24. Flowering Plants, Structure, Mode of Reproduction. From seed to fruit. Classification.

LIBRARY.

The year has seen large accessions to the library. Among donations specially worthy of mention are seven volumes of the *Educational Review*, from Mr. Geo. U. Hay, and a large number of zoological works from Prof. W. F. Ganong.

Prof. Ganong has also generously presented to the Society 200 copies of his work on the Economic Mollusca of Acadia, bound in cloth.

A valuable set of works on Palæontology has been acquired by purchase.

BOTANY.

This delightful study has been brought before the Society very prominently during the year. Six papers have been read on this subject, and in the elementary course three lectures have been given. A number of plants new to the province have been discovered, and a complete list of our mosses has been prepared by that veteran student, Mr. John Moser. Messrs. Hay and Ganong have undertaken a new text-book in botany suitable for these Atlantic Provinces, and it is confidently expected that the proposed work will do much to increase the widening popularity of this science.

MUSEUM.

The Custodian has continued mounting the European plants and doing other museum work. The rooms received a thorough cleaning, and the collections are all in fair condition.

The Room Committee have had the entrance and halls thoroughly cleaned and painted. The mammals have been removed from the Lecture Hall to the room up-stairs, formerly used as a laboratory. It is considered that this change will be an improvement.

The rooms have been open as usual, and a large number of visitors have examined the collections.

PUBLICATIONS.

Bulletin XII will be issued shortly and sent to members. It will be found a number of unusual interest. A number of papers have been published in the daily press.

The Council regret that limited means makes it impossible to publish a larger Bulletin.

GEOLOGY.

The Geological Committee report some additions to the museum. Special reference is made to a fine collection of fossils from the drift of Bedfordshire, Great Britain, presented by Charles R. Fisher.

Geological work in the vicinity of St. John has been prosecuted by members of the Society, and by visitors from various colleges and technical schools in the United States. Among the former, one of our corresponding members, W. D. Matthew, has during the past summer been pursuing his studies on the volcanic rocks around St. John.

Among the visitors who were here in the past year were professors from Columbia College, Yale College, and the Institute of Technology, Boston.

GENERAL.

During the year no summer camp was held, but many members spent some time afield. Our president made a hasty visit to the Devonian deposits at Lepreau Basin, with a view of holding a summer camp there next season. Vice-president Hay made an excursion to the Upper St. John. Dr. Cox has been working hard at his special work, and Mr. F. G. Berton and the Secretary made a survey of the sea-shore plants in the vicinity of St. John.

We record with pleasure our hearty appreciation of the support given to this Society by the ladies. In almost every department of human activity women are showing that they are capable of taking an advanced place. In England Miss Raisin and Miss Crane, and in the United States Miss Rosa Englemann have done scientific work of great merit, and won a recognized place in the world of science. And it is a matter for congratulation that we have in our midst some ladies who have done good local work in natural science.

The Society gave a conversazione to the members of the New Brunswick Educational Institute, which met last June in this city. About 500 were present, and a very pleasant evening was spent. The Society has continued to co-operate with the University Extension movement, and two courses will be given in our rooms this winter. Our president gives four lectures on Invertebrates, and will be followed by Dr. Cox with four on Vertebrates.

The Council wish to thank the press of St. John for the free insertion of preliminary notices of meetings, and they also thank all who have prepared papers for the Society.

One-third of a century has passed away since the foundation of this Society. Many of those who were active in carrying on the work in years gone by are no longer here, but their work remains.

The collections have assumed valuable proportions. In geology, mineralogy, archæology, botany, molluscs, fishes and birds, we have excellent collections that would be valued by any museum in Canada, and we look forward to the day when public liberality or private munificence will provide for them a fit and proper home.

These collections are not ours—they belong to the people of New Brunswick, and we hope that an enlightened public spirit will see that such a valuable heritage be preserved for generations to come.

Respectfully submitted,

SAMUEL W. KAIN,
Secretary to Council.

NATURAL HISTORY ROOMS, MARKET BUILDING,
St. John, N. B., January 15th, 1895.

DONATIONS TO THE LIBRARY, 1894.

Donor's Name.	Residence.	Work.
Royal Society	London	Proceedings.
Geological Society	do	Abstract Proceedings.
Director Royal Gardens	Kew	Bulletins.
Manchester Geological Society	Manchester	Transactions.
Biological Society	Liverpool	Proceedings and Tran
Marine Biological Association	Plymouth	Journal.
Belfast Naturalists' Field Club	Belfast	An. Report and Proc.
Royal Society of Canada	Ottawa	Proceedings and Tran
Ottawa Field Naturalists' Club	do	Ottawa Naturalist.
Director Experimental Farms	do	Report.
Department Inland Revenue	do	Bulletins.
Canadian Institute	Toronto	Transactions.
Entomological Society of Ontario	London, Ont	Can. Entomologist
Natural History Society	Montreal	Can. Record of Science
Historical and Scientific Society of Manitoba,	Winnipeg	Transactions and Rep
Natural History Society of British Columbia	Victoria, B. C.	Bulletin.
Nova Institute of Natural Sciences	Halifax, N. S.	Proceedings.
New Brunswick Historical Society	St. John, N. B.	Collections, Vol. I.
The Author (Geo. U. Hay. M.A., F.R.S.C.)	do	Flora of N. Brunswick
The Author (Geo F. Matthew.)	do	Illus. of the Fauna of the St. John Group.
Geo. U. Hay	do	Educ. Review, 7 vols.
E. A. Charters	Sussex, N. B.	Pamphlets.
William F. Ganong	(Northampton, Mass.)	156 vols. and pamphlets, mostly treating of marine zoology.
The Government of Ontario	Toronto,	Forestry Rep., 1886-91
Toronto Public Library	do	Report.
University of Toronto	do	Pamphlet.
Geological Survey of New South Wales	Sidney, N S.W.	Reports.
Australian Museum	do	Catalogue of Birds.
Australian Assoc. for Adv. of Science.	do	Report of 4th Meeting
Linnean Society of N. S. W	Elizabeth Bay,	Proceedings 1883-94.
Government Geologist.	Perth, W. Aus.	Reports.
New Zealand Institute	Wellington, N.Z	Proc. and Trans. Vol. 26
U. S. Geological Survey	Washington,	Reports, Bulletins and Monographs.
Bureau of Ethnology	do	Reports and Bulletins
U. S. Fish Commission	do	Reports and Bulletins
U. S. National Museum	do	Report and Proceed's
Smithsonian Institution	do	Report.
U. S. Dept. of Agriculture	do	Reports, 1888 to 1892.
U. S. Dept. of Agriculture (Botanical Division)	do	Bulletins and Contributions from U. S. National Herbarium
U. S. Coast and Geodetic Survey	do	Report.
International Geological Congress	do	Proceedings, 1893.
University of California	Berkley, Cal.	Bulletins & Pamphlets
University of Michigan	Ann Arbor	Reports & Pamphlets.
Cornell University	Ithaca, N. Y.	Bulletins.
Tufts' College	Tufts Col., Mass	Studies.
Johns Hopkins University	Baltimore, Md.	Circulars.
Amherst College		Calendar.
Boston Society of Natural History.	Boston	Proceedings.
Marine Biological Laboratory	do	Annual Report.
Boston Public Library	do	do.
Essex Institute	Salem	Bulletins

DONATIONS TO THE LIBRARY — (*Continued.*)

DONOR'S NAME.	RESIDENCE.	WORK.
New York Microscopical Society	New York	Journal.
New York Academy of Sciences	do	Transactions.
American Museum of Natural History	do	Report and Bulletin.
Linnean Society of New York	do	Abstract of Proceed.
Nat. Science Assoc. of Staten Island	New Brighton	Proceedings, 4 vols.
Rochester Academy of Sciences	Rochester, N.Y.	Proceedings.
New York State Museum	Albany, N. Y.	45th and 46th Annual Report.
Iowa Academy of Sciences	DesMoines, Ia.	Proceedings, 1893.
Tacoma Academy of Sciences	Tacoma. Wash.	Proceedings.
Academy of Natural Sciences	Philadelphia	do
Prof. E. D. Cope	do	Several Pamphlets.
Colorado Scientific Society	Denver, Col.	Proceedings.
Cincinnati Society of Natural History	Cincinnati, O.	Journal, Vol. XVII.
Public Museum	Milwaukee. Wis	Eleventh Annual Rep
Missouri Botanical Garden	St. Louis, Mo.	Annual Report, 1894.
National Museum of Costa Rica	San Jose	Report.
Museu National	Rio de Janeiro.	Archivos, Vol. VIII.
Societe Scientifique du Chile	Santiago	Actes, 1894.
Adrien Dollfus	Paris	Feuille des Jeunes Naturalistes.
Societe Royale Malacologique de Belgique	Brussels	Proceedings.
Vereins fur Erdkund	Leipsic	Mitteilungen, 1894
K. K. Naturhistorischen Hofmuseum	Vienna	Annalen, 1893.
Comite Geologique du Russie	St. Petersb'g	Memoirs & Bulletins.
Imperial Academy of Sciences	do	Bulletins.
Royal Swedish Academy of Sciences	Stockholm	Proceed. and Bulletins
Royal University of Norway	Christiania	Description of Norwegian Rocks by Dr. Kjerulf.

PURCHASED.

Reports of Geological Survey of Illinois, Vols. I-VIII
Report U. S. Geological Survey of the Territories, Vol. III, Book I.
Geology of Iowa, Vol. I, Parts 1 and 2.
Text-Book of British Fungi, by Wm. Delisle Hay.
Maury's Physical Geography.

NOTE.— *The Library is open every Tuesday evening.*

DONATIONS TO THE MUSEUM.

DATE.	DONOR'S NAME AND DESCRIPTION OF ARTICLE.
1894. *Feb.*	FRANK E. HOLMAN ESQ.—Albatross, mounted, in glass case.
	GEOFFREY STEAD, ESQ., C.E.—Indian relics from Grand Cane, La., U. S. A. Arrow Heads of Stone mounted on four cards. Ring-necked snake, Portland, N. B.
Mar.	VANWART BROS., St John, N. B., Cryptocanthodes maculatus (the wry-mouth), St. John Harbor.
Apr.	MISS BESSIE MATTHEW, St. John, N. B., Spanish Moss from Florence, S. C.
Oct.	MRS. WM. BOWDEN, St. John, N. B., Stone Arrow Head, Sandy Point, St. John County.
	MRS. MARY LAWRENCE, St. John, N. B., Caribou, mounted.
Nov.	WM. M. MCLEAN, ESQ., St. John, N. B., Sea Turtle, Bay of Fundy.
Dec.	DR. H. M. AMI, Ottawa, Ontario, Post Pliocene Fossil Fish, (Capelin) Green's Creek, Ottawa River.

OFFICERS AND COMMITTEES OF THE NATURAL HISTORY SOCIETY FOR 1895.

Patron—His Honor the Lieutenant Governor, Honorable John James Fraser.

COUNCIL FOR 1895.

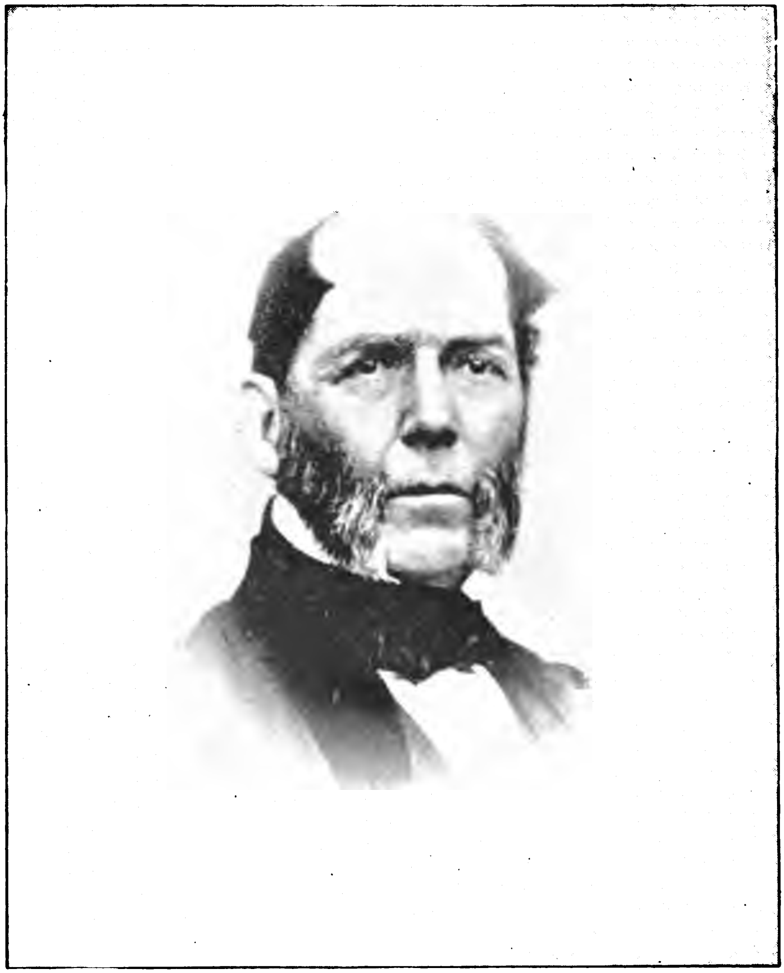
President—Geo. F. Matthew, D. Sc., F. R. S. C.
Vice-Presidents—Geo. U. Hay, M. A., F. R. S. C., Wm. M. McLean, M. A.
Treasurer—Alfred Seely, Esq.
Secretary—Samuel W. Kain, Esq.
Curators—Wm. Murdoch, C. E., H. G. Addy, M. D., Charles R. Fisher.
Additional Members—J. Roy Campbell, F. E. Holman and W. F. Best.
Delegate to the Royal Society of Canada—Samuel W. Kain, Esq

ASSOCIATE MEMBERS' BRANCH.

President—Mrs. Geo. F. Matthew.
Secretary-Treasurer—Mrs. F. E. Holman.

STANDING COMMITTEES FOR 1895.

Physics—Wm. Murdoch, C.E., W. F. Best, Geo. U. Hay.
Geology—Geo. F. Matthew, C. R. Fisher, L. W. Bailey.
Invertebrates—Samuel W. Kain, Wm. D. Matthew.
Vertebrates—W. M. McLean, H. G. Addy, W. W. White.
Ornithology—Philip Cox, Alfred Morrisey.
Botany—Geo. U. Hay, J. Vroom, Mrs. H. G. Addy, Mrs. Wm. Bowden.
Library—P. G. Hall, Wm. Murdoch, Mrs. Bowden, Miss G. Murphy.
Lectures—Geo. U. Hay, H. G. Addy, J. Roy Campbell, S. W. Kain.
Archæology—C. R. Fisher, Frank E. Holman.
Publications—Geo. F. Matthew, G. U. Hay, Alfred Seely, S. W. Kain, P. G. Hall.
Rooms—H. G. Addy, Wm. Murdoch, G. F. Matthew, S. W. Kain.
Finance—Alfred Seely, F. E. Holman, J. Roy Campbell.



Very Truly and
Fraternally yours
A Garner

BULLETIN

OF THE

NATURAL HISTORY SOCIETY

OF

NEW BRUNSWICK.

No. XIV.

PUBLISHED BY THE SOCIETY,

Price 50 Cents,

ST. JOHN, N. B.:
BARNES & CO., 84 PRINCE WILLIAM STREET.
1896.

BULLETIN
OF THE
NATURAL HISTORY SOCIETY
OF
NEW BRUNSWICK.

ARTICLE I.

DR. ABRAHAM GESNER—A BIOGRAPHICAL SKETCH.

BY G. W. GESNER.

Read April 7th, 1896.

Abraham Gesner was born in Cornwallis, Nova Scotia, May 2nd, 1797. His ancestors originally came from Germany, where Conrad Gesner three hundred years ago was so distinguished for his scientific attainments as to be called the Pliny of Germany, and was ennobled by the Emperor. A branch of the family afterwards settled in Zurich, Switzerland, where Solomon Gesner became distinguished as a poet, and where his fellow citizens afterwards erected a monument to his memory.

Another branch of the family settled in Holland, from which country Dr. Gesner's grandfather, Nicholas Gesner, emigrated to New York, and settled on the banks of the Hudson River at Tappantown, in Rockland Co., about twenty miles from the city of New York.

Henry Gesner, the father of the subject of the present sketch, one of the sons of Nicholas Gesner and his twin brother, Abraham, were about sixteen years of age when the American revolutionary war began. They were royalists, and incensed by the ill treatment of their father, Nicholas, by the cowboys of the time, one of whom removed the hat of the old man and substituted his own, saying that it was good enough for a damned tory, they crossed the Hudson at night and joined the British forces, then on the eastern bank of the Hudson, near Tarrytown.

Nicholas Gesner possessed a large property at Tappantown. The place where Major Andre was executed was upon the property of the Gesner family at Tappantown.

After serving in the war, the brothers were exiled with other royalists when New York was evacuated by the British, and went to Nova Scotia, where they were granted lands in lieu of those confiscated by the Continental Congress; the lands of Henry were situated in Cornwallis, near Cornwallis Dyke; those of Abraham in Annapolis Valley, near the mouth of the Annapolis river.

The brothers both remained staunch loyalists all their lives, and Henry often declared to his grandchildren that he believed in no other government but that of God and the king.

Among the sons of Henry Gesner were Abraham, the subject of the present biography, Gibbs and Henry. There were also several daughters.

Abraham, with the exception of the time he passed at Guy's and St. Bartholemew's hospitals in London, and "walked the hospitals," as it was termed, enjoyed no more than the ordinary instruction of the grammar schools of the day, but was always a great reader and a diligent student.

His diary, begun on the 2nd May, 1818, when he came of age, gives some revelation of his character at that time. He made several ventures in business, one of which was carrying horses to the West Indies. None of these were profitable, however, from causes beyond his control.

On one of his voyages he was wrecked in a gale at Wreck Hill, Somerset Parish, Bermuda, the vessel fortunately pounding over the reef before it went to pieces. He and the survivors were brought to Halifax by one of Her Majesty's frigates.

On another of his voyages he was wrecked in the schooner "Mason's Daughter" on Briar Island, at the entrance of St. Mary's Bay, Nova Scotia. The crew were washed ashore in a wintry surf, and barely escaped being frozen to death.

But his courage and industry were not quelled by these misfortunes.

At the age of twenty-eight he became a student of surgery at Guy's Hospital, and of medicine at St. Bartholemew's hospital, the first being under the direction of Sir Astley Cooper, and the other under that of Dr. Abernethy.

He was noted while at Guy's Hospital for his earnest application and also his deep spirit of piety. When any physiological mystery became a subject of speculation his ultimate reason was always, "God made it so," and the phrase came to be known as Gesner's reason, and was habitually used among the students.

He was married in 1824 to Harriet, daughter of Dr. Isaac Webster, of Kentville, Nova Scotia. His children, beside three who died in infancy, were Henry, William, George Weltden, Abraham Herbert, Brower, John Frederick and Conrad. Of these two survive at the present time, George Weltden and John Frederick, both of whom are chemists and metallurgists and patentees of improvements in various branches of applied science.

They reside in New York. Brower became a surgeon in the United States army, and Herbert an eminent clergyman of the Episcopal church. Herbert's sons Anthon and Richmond are also clergymen.

After taking his degree in medicine and surgery in London, Dr. Gesner resided at Parrsboro, Nova Scotia, and was for a long time a country medical man, travelling along the shores of Minas Basin in his neighborhood and returning after visiting his patients with his saddle bag laden with specimens from along his route. His way lay in a district which was extremely rich in finely crystallized mineralogical specimens.

In 1836 he published "Remarks on the Geology and Mineralogy of Nova Scotia," and in 1838 was appointed Provincial Geologist of the Province of New Brunswick, and moved to St. John, making it his headquarters while engaged in the explorations embodied in his reports on the Geological Survey of the Province of New Brunswick, printed by the government of that province.

While living at St. John, Dr. Gesner established the Gesner Museum, afterwards purchased by the Natural History Society of New Brunswick. Its formation began with his personal collections in his various explorations. Many specimens he obtained at Parrsboro. Blomidon, on the opposite side of the Minas Basin, was a favorite locality for his researches, and all the places mentioned in his "Remarks on the Geology and Mineralogy of Nova Scotia" were visited by him in person. The animal portion of the museum was brought together at St. John. The birds were a portion of what had fallen before his own gun, as he was an excellent shot.

The moose, deer, caribou and larger animals were all stuffed and preserved at St. John, at his residence on McNab's Hill, and in setting them up several Micmac

Indians were employed, and almost any evening during the progress of the work a group of them could be seen sitting about the fire, at the end of a large attic, smoking killikinick and chatting in their soft tongue before wrapping themselves in their blankets and going to sleep.

These Indians, many of whom were Dr. Gesner's guides in his surveys, and who were good judges of the natural attitudes and appearance of the stuffed animals, were very capable assistants in setting them up. Dr. Gesner's own study of the forest and its denizens had been careful and observant, and made him proficient for the work in hand. The Indians gave him a title, signifying "Wise Man."

After leaving St. John he returned to Cornwallis, Nova Scotia, and resided at the old homestead of his father, Henry Gesner, and there wrote his "New Brunswick, with Notes for Emigrants," and the "Industrial Resources of Nova Scotia."

He engaged meanwhile in such medical practice as the country offered, and in further study of science as applied to arts and manufactures. The dynamo of the present time was foreshadowed by many of his experiments at this place. The appliances used for covering wire with insulating material by a peculiar winding apparatus were a portion of his work.

He also constructed an electrical engine, or motor, which was driven by a voltaic battery, the principle being practically identical with that now used in electrical motors, electrical lighting and other electrical applications.

In 1850 he removed to Sackville, near Halifax. He moved to Halifax in 1852.

At Halifax he met Lord Dundonald, then admiral of B. N. A. station, who was the original discoverer of illuminating gas, and with him examined the asphaltum of the pitch lake of Trinidad, and from it extracted a burning oil for lamps. Afterwards he extracted an illuminating oil from coal and other bituminous substances, and in 1854 patented it under the name of Kerosene in the United States. This invention laid the foundation in America of a large industry, leading to the use of petroleum for illuminating purposes and to the enormous petroleum industry as it now exists.[*]

At the time Dr. Gesner began the manufacture of Kerosene at New York, camphene—a mixture of alcohol and spirits of turpentine and whale oil — and certain vegetable oils, were with tallow and spermaceti candles used for affording light as well as gas.

In the manufacture of oil from coal and bituminous matter, a waxy substance called paraffin was produced in considerable quantity, and in naming the new oil it was thought best to call it "wax oil" from the Greek words *keros* "wax," and *'elaior* "oil." The term "Keroselene" was first proposed and afterwards shortened to "Kerosene" to distinguish oils of this kind , and under that name was patented.

Even with the best skill at command the first kerosene, or coal oil, as it was also called, had when prepared for market, very considerable odor. The kerosene oil works on Newton Creek, near Penny Bridge, a locality now termed "Blissville," was in 1856 quite a landmark among the factories along the creek.

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[*] A copy of this paragraph was sent to the Commissioner of Patents, Washington, D. C., U. S. A., with a request for an official confirmation of the claims of Dr. Gesner to this important discovery, and the following reply has been received:

DEPARTMENT OF THE INTERIOR.
UNITED STATES PATENT OFFICE.
Washington, D. C., June 4, 1896.

MR. PERCY G. HALL, Secretary of N. H. S. of N. B.
Market Building, St. John, New Brunswick.

SIR,—In reply to your letter of May 30th, you are advised that patents Nos. 11,203, 11,204 and 11,205 were issued June 27, 1854, to Abraham Gesner, assignor to the Asphalt Mining and Kerosene Gas Co., of Williamsburg, N. Y., for manufacturing kerosene oil.

Copies of the drawings of above patents can be furnished for ten cents each, and manuscript copies of the specifications for ten cents per hundred words.

By order of the Commissioner. Very respectfully.
GEO L. MORTON, *Chief Clerk.*
Please refer in answer to letter 72,814. Per W. W. H.

In 1861 Dr. Gesner published "Coal, Petroleum and other Distilled Oils," and in 1863 returned to Halifax, where he resided until his death. He was a man of great energy and industry, and capable of enduring enormous labor. His explorations, particularly those of the Tobique and Madawaska rivers in New Brunswick, were enough work for most men in his profession, but when to these is added the effort necessary to give to his invention of Kerosene and its introduction, which was very difficult at first, the magnitude of his labor can be appreciated.

Sir Charles Lyell and Sir Roderick Murchison understood and expressed their appreciation of his geological abilities.

Shortly before his death he was offered the chair of natural history in Dalhousie College, Halifax. He was a fellow of the Geological Society of England, corresponding member of the Royal Geological Society of Cornwall, member of the Literary and Historical Society of Quebec, corresponding member of the Academy of Natural Sciences of Philadelphia, and a member of the Geographical Society of New York.

Dr. Gesner was a man of medium height, but with deep chest and square shoulders. He had black eyes, which shone brilliantly when he was excited, or in earnest conversation. His face in repose always showed reflection and deep thought, and gives one the impression of strong intellectual power. His hair was black to the end of his days — he died at the age of sixty-seven.

He had a habit when telling a good story of scratching his head with his hand, in a quick, nervous way, when he came to the point, and laughing heartily. His lively disposition probably came from his French blood

—his mother being a Pineo—a member of the Acadian family of that name.

Dr. Gesner was popular with those with whom he came in contact, and suggestions of political success and preferment were often made to him in consequence, but he could not be induced to enter the political arena, but remained true to his beloved science. He was an enthusiastic sportsman, both with rod and gun, and we have seen how he made these accomplishments the handmaids of his scientific labors.

He was very fond of music and quite a capable performer on the flute and violin in the family circle. After a wearing day's work he would seek recreation and pleasure in playing over old airs, especially the Scotch music, of which he was particularly fond. He was always abstemious and temperate in his habits of life, but liked and would smoke a good cigar. He rose early and retired early, believing in the old maxim with reference to sleeping.

Many anecdotes might be told showing the geniality and generosity of his disposition.

He remained a firm churchman all his life, and was a warden for many years of Christ Church, Brooklyn, N. Y. Here he had an opportunity of entertaining many of the clergy, some of whom had large parishes in New York. On one of these occasions he somewhat disturbed the pious serenity of a very wise looking theologian who was dining with him, and whose name was Walton, by smilingly inquiring if he was any relation to the famous Isaac Walton, author of the "Complete Angler."

A story is told showing the natural generosity of his character when superintending a Sunday-school picnic of the church to which he belonged. The picnic was held in grounds surrounded by a high board fence to protect the scholars from a great band of waifs from the street, who had collected on the outside and were clamoring for something to eat. It was not long before the doctor had a barrel well packed with provisions thrown over the fence to the great delight and satisfaction of those outside, although they did not belong to a Sunday-school, as it broke on the ground and scattered its dainties far and wide.

Dr. Gesner lies buried in Camp Hill cemetery, Halifax, Nova Scotia.

Dr. Gesner's Reports on the Geology of New Brunswick are now difficult to obtain. Prof. L. W. Bailey and Dr. G. F. Matthew each possess a full set, the Library of Parliament has the third report, Boston Public Library two or three reports, Boston Society of Natural History two or three reports, Harvard has none, and Prof. W. F. Ganong has the first report.

The reports were issued as follows :

First Report on the Geological Survey of New Brunswick, 1839, Henry Chubb, St. John, 87 pages.
Second Report on the Geological Survey of New Brunswick, 1840, 76 pages, eleven woodcuts.
Third Report on the Geological Survey of New Brunswick, 1841, 80 pages, nine woodcuts.
Fourth Report on the Geological Survey of New Brunswick, 1842, 101 pages, eight woodcuts.
Topographical and Geographical Report, 1843, 88 pages.

The size of the page is five by eight inches.

Dr. Gesner's geological map of New Brunswick, now the property of the Natural History Society, embodies the observations contained in Reports 1–3.

ARTICLE II.

THE RESTIGOUCHE — WITH NOTES ESPECIALLY ON ITS FLORA.

By G. U. Hay, M.A., F.R.S.C.

(Read December 1st, 1896.)

Last summer, in company with Dr. W. F. Ganong, I made a trip down the Restigouche in a canoe. On the morning of the 25th July, we started from St. Leonard's Station, about thirteen miles above Grand Falls on the St. John, and made the portage through to the headwaters of the Restigouche, twenty-five miles, arriving there about four o'clock that afternoon. Twelve days after we reached Campbellton after a most delightful trip, in almost uninterrupted fine weather, and upon a river that has no superior in romantic and picturesque scenery, even in this province of beautiful rivers.

Twelve years ago when I stood on Bald Mountain at the head of the Tobique and looked over the expanse of virgin forest, amid which the Restigouche threads its way through a wild and deep valley seaward, I had a desire to know more of a river that is alike the sportsman's paradise, the delight of artists, and almost a *terra incognita* to naturalists. With an appetite sharpened by twelve years of waiting, I became a willing partner in last summer's excursion.

For the first twelve miles of our portage through from the St. John to the head waters of the Restigouche we had a good road. Our portageurs — three men in all — drove ahead on a stout wagon drawn by two horses, with our canoe and baggage, while we brought up the rear in a light wagon. The remaining thirteen miles we made mostly on foot over a very rough road.

The morning was bright and beautiful, and for two or three miles we drove along the banks of the St. John until we came to the Grand River, up the ridge bordering on whose valley we were soon winding by a succession of hills that brought us gradually to the northern watershed of New Brunswick. The view from one of the highest of these hills is strikingly picturesque. Behind us lay the broad valley of the St. John flowing with sweeping majestic curves from its home in the northern wilderness, passing the quiet villages of St. Leonard's and Van Buren, and then continuing in a long, quiet stretch as if preparing for the rush and leap at the Grand Falls. On the opposite side of the St. John lay the highlands of Maine. On our right was the narrow gorge of the Grand River, and on our left the valleys of the Siegas and Quisibis with the lofty peaks of Green River and Quisibis Mountains in the distance. Except the narrow settlement we were going through, all around was an unbroken wilderness. Along the Grand River Settlement there were three grades of settlers, nearly all French, or descendants of French, from the Province of Quebec and Madawaska County. The first grade included the oldest settlers, with passably comfortable houses, a considerable acreage of land reclaimed from the forest, with fields showing a more or less scientific attempt at cultivation. The second grade showed a link between the modern and the settler of bygone years. There was the frame house, and near by the tottering remains of the old log cabin where the "rude forefathers of the hamlet" dwelt, now a picture of ruin and distress. For what more distressed picture is there than an old house, which in its day merely served the purpose of shelter? The last or frontier settlement is on the verge of civilization, and we are standing before the last hut before plunging into the forest. And this hut is typical of a dozen that we have seen in the last few miles. Not a vestige of a tree or shrub around the bare and comfortless hovel; a half starved geranium in the only window that fronted the roadway; a group of shy children that refused our advances and scattered to the rear of the house on our approach; a dog that growled sullen defiance and betook himself to the door where he showed his gleaming teeth in a very unmistakable way.

It is not to be wondered at that we bade good-bye to civilization (?) on that hot July day, and betook ourselves to the grateful shade of the forest with the liveliest relief and satisfaction. A great city is not the only place where we meet with extremes of wealth and poverty, of high life and low life. As we entered the woods and saw those aristocratic elms and maples and pines, we were impressed with their magnificence, and could not help thinking that if those poor settlers, when they carved homes for themselves in the wilderness had thought that they had other wants to satisfy than mere physical wants, they would have left standing one or two lordly forest trees and reared their humble roofs under their grateful shade. It seems to me that the Giver of all blessings would look down upon such a habitation as that and pronounce it "good." How much better is man, both physically and intellectually, with trees as neighbours and companions, beneath whose cool shade he can rest himself and smoke his pipe in contentment as he surveys his growing acres, and thank God for them all.

And yet in that whole settlement there was not a shade tree worthy the name, but instead a mournful line of wretched dwellings strung along the road. The man had been swallowed up in the wood chopper and *he* thinks only of chopping down the native growths, clearing up the vines and trees and shrubbery and sacrificing everything to present utility. He begrudges a few inches of soil to the rightful owners, who would thankfully bless him every day of his busy life for sparing them. But instead of thinking of the tree as a friend the settler looks upon it as an enemy, one that must be rooted out and destroyed. And tree murderers are not confined to Madawaska County.

But I started out to write notes on the flora of the Restigouche. A few miles from St. Leonard's we saw a honeysuckle which proved to be the Swamp Honeysuckle (*Lonicera oblongifolia*), a plant new to our provincial flora. Through the settlement we found the same weeds disputing the possession of the soil with the farmers as we find in other places. The Ox-eye Daisy and the Cone-flower (*Rudbeckia hirta*) in the grass-fields, the Wild Mustard in the grain fields, and a profusion of Campion flowers (*Silene Cucubalus*) on the roadside. When we entered the forest our road, which had to be cut at intervals, lay along beautiful stretches of woodland chiefly rock maple and yellow and gray birch, with a beautiful under-shrubbery of *Viburnum lantanoides.* The gentle ascents were clothed with mosses, the Twin Flower (*Linnæa borealis*), scenting the woods with its fragrant odor, and the White Oxalis (*Oxalis acetosella*), in contrast with sphagnums of the hollows with dense shrubbery of viburnums and cornuses, with pyrolas in bloom, and with some fine specimens of *Habenaria orbiculata*, its loose spike of greenish-white flowers with their long spurs reminding one strongly of tropical orchids. This water shed, dividing the St. John from the Restigouche, is a gently undulating tableland, elevated about eight hundred or a thousand feet above the sea-level and well watered. Many of the streams trickle slowly through swamps and find their way either to the tributaries of the St. John or Restigouche. It has a soil, to judge from the vegetation upon it, nowhere exceeded in richness throughout this province, except in the alluvial valleys of its chief rivers. Derived from the disintegration of the underlying Silurian slates, the soil is apparently of considerable depth, remarkably free from stones, and would form a rich agricultural district if rendered more accessible by post road and railway. A railway across the northern part of New Brunswick from the Bay of Chaleur to the valley of the St. John, would open up for settlement this rich tract of watershed and the upper Restigouche, and bring into general view some of the most rugged and picturesque scenery of Eastern Canada. But this grand primeval wilderness would be blackened and desolated by forest fires,—the sure attendant of frontier settlements. The shrill whistle of the locomotive would be daily heard in those solitudes whose silence is only occasionally broken by the gentle sounds of the canoeman's paddle, the whir of the angler's rod, the ringing echo of the sportsman's gun, or the clear strokes of the lumberman's axe. The adventurous spirits who love these solitudes might wish that "the greatest good to the greatest number" would be indefinitely postponed, and that the difficulties in the way of railroad communication may prove an insuperable obstacle in breaking up this sportsman's paradise.

About four o'clock on the afternoon of July 25th, our ears were gladdened by the welcome sounds of rippling waters, and in a few minutes we stood on the bank of the Restigouche, whose praises have been celebrated in poetry and prose by delighted anglers from both continents. Its clear waters now gliding swiftly over the pebbly bottom, now reposing in some quiet pool, gave the anglers an invitation to "cast" which was promptly accepted, and a few speckled beauties gave promise of sport and welcome additions to our not over-abundant camp supplies. We found the water very low — not deep enough in the shallow places to float a loaded canoe — and that meant work for the canoemen. But who would object to a little work in that clear mountain air and the prospect of a run of over a hundred miles on the Restigouche! We pitched our tent on that famous camping ground near the mouth of the Waagan, the resting place for many years of voyageurs like ourselves — a pretty bit of meadow but whose edges were blackened by the fires of too careless campers of other years. The camp of the absent warden was taken possession of by our guides, and before sundown we had everything in good shape for a comfortable night. But we had reckoned without our hosts — the flies. They came in swarms — mosquitoes, black flies, sand flies, bite-'em-no-see-'ems and others of the vile horde that are the anathema of woodsmen. We used all the resources at our command — smudges, veils, ointments and the mildest adjectives that our vocabulary would allow us to use, but they would not off. They wanted tribute and, like Macbeth, they would have blood. We paid the tribute as calmly as we could, and gained in experience what we lost in flesh. I took a bottle of villanous ointment that caused me more discomfort than the flies; a mosquito net kept out the largest and was not uncomfortable on hot days, with a breeze that would drive the air through it. A "smudge" is effective but it is as likely to drive you out of the tent as the flies. The best plan we found was to choose a camping ground in the woods, and when we did so were nearly free from discomfort. One night, at the mouth of the Gounamitz, we slept on a sand beach. We never repeated that experiment. The recollections of the moonlight effects on the bluff that towered more than a hundred feet from the water on the opposite side of the river, and the rugged beauties that the morning sunlight flashed back to us from those pinnacles of rock and tree, were no compensation for that night of sleepless torture. Never sleep on a sand beach; choose a ground a trifle elevated and leafy; build two or three fires not far from the tent door; keep good hours and close up the tent early; then, if you haven't been dodging the fish warden through the day, and your conscience is clear in other respects, you will probably sleep soundly.

The old route between the St. John and the Restigouche was by canoe up the Grand River and into one of its small tributaries, the Waagansis; thence by a "carry" of three miles into the Waagan, an affluent of the Restigouche, and down that stream to the spot where we made our first camp. But that is now practically impossible owing to the filling up of the slow-running Waagan, and the dense growth of bushes which almost conceals it. I could scarcely believe that it had ever been passable for canoes. But we saw it at the height of an unusually dry season.

One of the last plants that we saw on the borders of the Grand River Settlement was the Campion Flower (*Silene Cucubalus*). It was the first to attract our attention on the pebbly beaches of the Restigouche. It was almost constantly in sight on the whole course of the river. And yet it is not a native plant, but introduced on to this continent from the old world where it occupies wide areas from North Africa and India to the Arctic Ocean. It has evidently followed the footsteps of man, both as settler and explorer, for it is as abundant on the upper St. John as on the Restigouche. Its inflated grayish-green calyx is beautifully veined and surmounted by white petals. Growing in dense clumps, it is an attractive plant. In the woods near by we found our common Hop (*Humulus Lupulus*) and from its position here and at other points on the river it is without doubt indigenous to our province. I saw some fine specimens in fruit of the Wake-Robin or Nodding Trillium (*Trillium cernuum*), and several species of wild gooseberry and currants (*Ribes*).

I shall only make mention in connection with this trip of those plants that are new or rare to the province, or those that are striking by their great abundance, luxuriance of growth, or other distinguishing features. I feel sure that this, the first descriptive account of the flora of the Restigouche, will be full of interest to you, occupying as this river does, the northern limit of the province, and prior to the visit of Dr. Cox and Mr. Brittain, a few years ago, almost unknown to botanists. I wish to acknowledge at the outset my indebtedness to these gentlemen for lists of the plants they collected; to Messrs. R. Chalmers and R. W. Ells of the Geological Survey Department, whose valuable reports on the surface geology and forest growths of Northern New Brunswick I have availed myself of to a full extent; to Mr. Walter Deane, of Cambridge, for his assistance in identifying doubtful species; and chiefly to my sole companion of the voyage, Dr. W. F. Ganong, without whose knowledge of affairs and wide experience in wood craft, the trip could not have been made, and whose genial comradeship will always remain as one of the pleasantest features of the trip.

Let me attempt to give you a few general ideas of the topographical features of this northern heritage of ours. I may remind you that the chief watershed of New Brunswick extends from the extreme northwest limit of the province southeasterly to Baie Verte; that the eastern slope extending from this is drained by the Restigouche, Nipisiguit, Miramichi, and by a great number of smaller rivers. The south-western slope is drained by the St. John and its tributaries, and by smaller rivers. Next to the St. John and Miramichi the Restigouche is the largest river in New Brunswick. It is 150 miles long and drains an area within the province, of 2,200 square miles, about one-fifth of that drained by the St. John, and less than one-half the area drained by the Miramichi, although, as a whole, the basin of the Restigouche is nearly as great as that of the Miramichi. Its chief tributary from the south is the Upsalquitch, and three chief branches from the north are the Katawamkedgwick, the Patapedia, and the Metapedia, one of which at least is larger than the main stream; but the main stream is considered to have the right to the name because of its generally direct course from the watershed in Northern New Brunswick to the Gulf of St. Lawrence. The Metapedia is wholly a Quebec river, the Patapedia forms the boundary between this province and Quebec in the lower half of its course, while the Katawamkedgwick, wider and of greater volume than the Restigouche, where it joins the latter, flows only for the last forty or fifty miles of its course within New Brunswick territory. The wide divergence of these four tributaries from the main stream is the origin of the Indian name Restigouche (river of the five fingers). The Restigouche takes its rise in the north-east of the County of Madawaska, near Prospect Peak, and about twenty-five miles north-west of our camping ground at the mouth of the Waagan. Its waters are clear and cold, from the springs and lakes of the dense wilderness to the north,— and some of these sources are probably within the province of Quebec. Its flow is strong and swift, broken by rapids on an average of every one hundred yards, but nowhere impassable for a canoe. In its course of 110 miles, from the Waagan to Tide Head, above Campbellton, there is a descent of from 400 to 600 feet. The Restigouche flows through a narrow valley, growing deeper as you descend the stream, flanked by hills rising very steep from the waters' edge, but scarcely ever too steep not to admit of a luxuriant vegetation, chiefly evergreen. In the loops formed by its winding course there may be seen, at intervals, now a stretch of meadow land, now beautiful terraces from thirty to seventy feet above the river; but so suddenly does the stream change its course and rush to the opposite side again, that these meadows and terraces alternate from one side of the river to the other in quick succession. These level spots are clothed with the most luxuriant vegetation, whose vivid green contrasts with the clear, flashing waters below them and the dark evergreen of the hillsides beyond.

Can you imagine greater pleasure than this — to sit in a canoe, paddle in hand, and wind in and out at the rate of five or six miles an hour amid scenes like these? And how we wished when our journey was ended that we had gone more slowly! Yet we only ran three or four hours, on an average, each day.

I agree with the author of "Little Rivers" when he says: "A river is the most human and companionable of all inanimate things. It has a life, a character, a voice of its own, and is as full of good fellowship as a sugar maple is of sap. * * * * The life of a river, like that of a human being, consists of the union of soul and body. They belong together. They act and react on each other. The stream moulds and makes the shore; hollowing out a bay here and building a long point there; alluring the little bushes close to its side, and bending the tall slim trees over its current, sweeping a rocky ledge clean of everything but moss, and sending a still lagoon full of white arrow-heads and rosy knot-weed far back into the meadow. The shore guides and controls the stream * * bending it into a hundred sinuous curves * * here hiding the water in a deep cleft overhung with green branches, and there spreading it out, like a mirror framed in daisies to reflect the sky and clouds, sometimes breaking it with sudden turns and unexpected falls into musical laughter, sometimes soothing it into a sleepy motion like the flow of a dream." The author might have had the Restigouche in mind, for such a description suits it exactly.

With patches of meadow and terrace, near each other, yet separated by the river, and with precipitous hills rising on all sides, the upper Restigouche can never be a country of farms. The smallness of the terraces and meadows, the precipitous hillsides and wild scenery, are better suited for those fishing lodges, simply planned, all of them after the same pattern but in harmony with their surroundings, which we find farther down the river, perched above some salmon pool, and empty, except during the fishing season each year.

About 12 o'clock on the day following our arrival at the Waagan our guides left for home and we began the descent of the river. The prospect before us of a fortnight in the wilderness, the "paddling our own canoe" through those rapids of the curving gorges ahead, our independence of guides, the anticipation of the discovery of some new plant, sent the blood dancing in our veins with exhilarating flow as we seized our paddles and shoved out into mid-stream. The success of our expedition and our own safety depend on the careful handling of our canoe. Tenderly we lift it over shallows and guide it carefully and slowly through the swirling eddies as the river rushes past some precipitous bluff. Then, as we shoot out of the rapids and glide gently over some smoother current, we rest on our paddles and gaze for a moment on the wondrously beautiful scene around us. But it is only for a moment or two. The eager and impetuous stream ahead of us is chafing over pebbles and rocks, and we must choose the course that promises the greatest safety and the least labor. But it is done safely; and the caution and unerring instincts of the steersman were rewarded by not even the approach to an accident during the whole descent of the river. Here and there, as if to lighten our task, little brooks and larger streams came dashing in with their supplies, and the river grew more expansive and deeper, but more headstrong. Our course at first lay among gently elevated hills well back from the river, not more than fifty to one hundred feet in height, but the river seemed bent on diving farther and farther into the recesses of the earth. The gorge deepened as we advanced, and the hills grew into mountains until they attained in places an altitude of a thousand feet and upwards.

On our first afternoon we passed several fertile meadows where the Ostrich Fern (*Onoclea Struthiopteris*) grew in the greatest abundance, and so luxuriant that fronds six feet in height were not rare. This fern is probably the most abundant on the river, the rich alluvial soil and cool shady ravines furnishing a most congenial habitat. A shield fern (*Aspidium aculeatum* var. *Braunii*) was found growing with the Ostrich Fern in greater abundance than we had ever seen it before. Its fronds are usually a foot or so in height but one frond measured three feet in height. The deep green color of this fern and the light brown chaffy scales of the stipe and rachis make it one of the most beautiful and desirable of our ferns. The most common Ranunculus along the Restigouche was *Ranunculus septentrionalis*, especially on its upper waters, but *R. flammula* var. *reptans* was met with commonly on sandy shores, and *R. tricophyllus* in the shallow water of the ponds or bogans, where it is found with the Arrow-head (*Sagittaria variabilis*) and its many varieties, their white flowers covering the waters in greatest profusion. Hunter's Brook, about five miles below the Waagan, invited an exploration. It flows into the Restigouche from the south through a rocky gorge whose shelving and precipitous sides of calcareous slates were clothed with mosses and ferns of the most luxuriant growth. The common Rock Fern (*Polypodium vulgare*) which has been considered rare in northern countries is very abundant here. One frond measured eighteen to twenty inches in height. The green Spleenwort (*Asplenium viride*), the Bladder ferns (*Cystopteris bulbifera* and *C. fragilis*) and the Spleenwort (*Asplenium thelypteroides*) were growing here in unwonted size and variety.

The trees along the Restigouche are largely evergreen which would give a sombre character to the deep valley, but for the sparkling waters and the numerous windings which bring other characteristics rapidly into view. Of evergreens the White Spruce (*Picea alba*) is the most abundant. The Black Spruce (*Picea nigra*) is much rarer, while very few pines, and these only of one species, the White Pine (*Pinus Strobus*), are to be seen along the river. The Cedar (*Thuya occidentalis*), is quite common, so also is the Balsam Fir (*Abies balsamea*), whose long, slender trunks often rising to the height of seventy or eighty feet and clothed with Old Man's Beard (*Usnea barbata*), are a conspicuous object along the banks. No tamaracks were seen on the banks of the Upper Restigouche and but few farther down. Of deciduous trees, the balsam poplar (*Populus balsamifera*) is the most abundant on the low grounds, and is found everywhere along the river. Elms, black, white and yellow birches, the white and black ash, maple, especially the red maple (*Acer rubrum*), with alders. Willows and sumachs are quite common.

The second day's run brought us to the mouth of the Gounamitz (Little Forks) about fifteen miles below the mouth of the Waagan. This is the first large tributary of the Restigouche and flows in from the north. The scenery about the mouth is very wild and picturesque, the cliffs rising from the river to the height of over one hundred feet. At the base of these cliffs we found growing that delicate and beautiful fern the Cliff Brake (*Pellæa gracilis*), and the *Asplenium viride*, lichens and mosses in the greatest variety and abundance, giving promise of rare and perhaps new species had we taken the opportunity to collect them. Patches of dandelion and ox-eye daisy and the song of a robin remind us we are not beyond the pale of civilization. Here we find a violet (*Viola primulæfolia*), rare in this province. A mile below the forks of the Gounamitz is Boston Brook, evidently a favored camping ground. Here we found growing in considerable abundance a vetch with yellow flowers (*Lathyrus pratensis*), the only place on the river where we noticed it. Below Boston Brook the country changes to a marked extent from a hilly to a level country, but only for a mile or two,—a good site for a frontier settlement. A short distance further down, just below

Jardine's Brook, the Silurian ledges cropping out remind us of the Upper St. John and its flora. Here we find the first wild rose met with on the trip (*Rosa Carolina*), two anemones (*Anemone Pennsylvanicæ*) and *A. cylindrica*, the Painted Cup (*Castilleia pallida* var *septentrionalis*), *Hedysarum boreale*, the Poison Ivy, (*Rhus toxicodendron*), the Bilberry (*Amelanchier Canadensis*), *Lobelia Kalmii* and others — all Upper St. John plants.

Our fourth camping ground was near the mouth of the Kedgewick which here comes in from the north and is the largest affluent of the Restigouche. There is a fine stretch of meadow land here and a good farm, the first met with on the river, owned by Mr. Mowatt. We went about half a mile up the Kedgewick, found several rare carices, and an evening primrose (*Œnothera Oakesiana*. A little below the mouth of the Kedgewick on the right bank of the river is the fishing lodge of Col. Rogers, of New York, who owns the famous fishing pool known as "Jimmy's Hole" where the water is from thirty to forty feet deep, a steep wall of white rock rising from the eastern side; and next is Soldier's Gulch, the best salmon pool on the river. A little below on a picturesque little nook at a bend of the river we come upon the summer camp of Mr. Ayer, of Bangor, and two miles farther we reach Down's Gulch, a fine camping ground. Here we found the Grass of Parnassus (*Parnassia Caroliniana*), *Tofieldia glutinosa*, *Hedysarum boreale*, *Astragalus alpinus*, very abundant along the lower river, the purple fringed Orchis (*Habenaria psycodes*), the Rock Strawberry (*Fragaria vesca*), *Anemone cylindrica*, several rare carices and several species of juncus. For the next ten miles we pass through some of the most striking and picturesque scenery on the Restigouche. The river makes sudden turns, and leaps tumultuously from rapid to rapid, vainly strikes against the base of a rocky eminence and recoils, seething and foaming, to take a great sweep to the right, and seek a sullen repose in the great black pool beyond. There seems scarcely room enough for the river in the narrow gorge through which it rushes, careering to almost every quarter of the compass. Salmon pools are frequent and very deep. The hills rise to the height of six hundred to eight hundred feet, and the presence of more deciduous trees, such as maples and birches renders the foliage less sombre than farther up the river. Opposite the frequent bends in the river are numerous terraces from thirty to fifty feet high, some of them, especially those at Red Bank and the mouth of the Patapedia, being of considerable extent and all in the most picturesque and beautiful situations imaginable, sloping down to the edge of deep pools and giving the opportunity to view from their vantage ground scenery that cannot be equalled in these provinces. Nearly all these terraces have fishing lodges built upon them owned by the Restigouche Salmon Club.

The Devil's Half-Acre, as might be supposed, is one of the wildest and most rugged spots, and is a precipitous bluff, whose rocky base is surmounted by calcareous slates, rising from the river to a height of some three hundred feet. His satanic majesty's preserve, however, was a very good botanical ground. The Buffalo-berry (*Shepherdia Canadensis*), *Polypodium vulgare*, *Woodsia Ilvensis*, *Solidago squarrosa*, *Potentilla arguta*, roses and pyrolas occurred, and several heath plants were seen here, although this family is somewhat rare on the Restigouche. Nearly opposite the mouth of the Patapedia (Pata-pee-jaw, with a strong emphasis on the last syllable, is the local name) is a large farm owned by Mr. Wyer, and there is considerable interval land in the vicinity. Although the salmon season was about over there was one angler who was paying his second visit to the famous pool at the mouth of the Patapedia — the Rev. Dr. Rainsford of New York, and the next morning we enjoyed salmon fishing — by proxy.

Cross Point is a romantic spot on this most picturesque part of the river. Climbing to the top of the rocky and dizzy height which is surmounted by a rough wooden cross, we overlook a magnificent stretch of endless hills and gorges. Three hundred feet below us the river flows in a northeast direction and curving round, forming an oval peninsula, takes a directly opposite course. So closely does the river double on itself that one can sit on the narrow mountain ledge, about the width of a saddle, with a foot dangling over each stream. It is not a spot that would insure peaceful dreams for the following night if one remained very long upon it.

From the mouth of the Patapedia down we have Quebec Province on our left and New Brunswick on our right, for from the mouth of this river to the Bay of Chaleur the Restigouche forms the boundary line between the two provinces.

Our camping ground on the night of 31st July was Tom's Island, which we reached just at dark; a clear, cold night with frost or a very near approach to it — and no flies! This island, situated at the mouth of Tom Ferguson's Brook, proved so interesting in its variety of plants that we spent the greater part of the next day in investigating them. The island — or rather peninsula at low water — forms the apex of a bend in the river. The isthmus connecting it with the right hand bank of the river is of Upper Silurian limestone, highly tilted, and no doubt underlies the island. The central portion of the island is about one hundred yards long and twenty wide in the broadest part, covered with alluvial soil, and bearing a dense vegetation, with a margin extending up river about four hundred yards of more stony material bearing shrubs and low herbs. It can readily be seen that an island in this position at a point where the river almost doubles on itself, and with a stream flowing into it from a direction opposite to that of the river would be in a good position to receive plant seed and should have a varied plant growth, and so it proved. In this limited area and on the adjoining isthmus we found over one hundred different species of flowering plants. The examination of the island proved so interesting that I must make it the subject of a separate article. I observed here the Huronian Tansy (*Tanacetum Huronense*), its first station on the river, and further east, I believe, than it has ever been noted on the continent.

We camped over Sunday on a terrace overlooking the chain of rocks, having passed safely through Hero's Rapids, the most dangerous on the river. Here we found Butterwort (*Pinguicula vulgaris*), the Shrubby *Cinque*-foil (*Potentilla fruticosa*), the Cleft-leaved Anemone (*Anemone multifida*), the Ground-nut or Wild Bean (*Apios tuberosa*), the Wild Onion (*Allium Schœnoprasum*), the Marsh Marigold (*Caltha palustris*), the Primrose or Cowslip (*Primula Mistassinica*), *Pellæa gracilis*, *Desmodium Canadense*, the Milk-vetch (*Astragalus oroboides*), the Beach Plum (*Prunus pumila*), *Oxytropus campestris* var. *caerulea*, the Bearberry (*Arctostaphylos Uva-ursi*), the Milkweed (*Asclepias Cornuti*), the Rattlesnake-root (*Nabalus racemosus*, the Pale Touch-me-not (*Impatiens pallida*), and other interesting forms.

Pinguicula vulgaris, which was discovered by Dr. Cox and Mr. Brittain on their trip down the Restigouche a few years ago, is a most interesting addition to our New Brunswick flora. It is probably in this province confined to the Restigouche, and, so far as determined, occupies a narrow strip extending about twenty miles, from the Chain of Rocks to half a mile below Morissey's Rock. It belongs to the insectivorous plants, and one might wish that it was found in much greater abundance through the whole length of the Restigouche. Its area of distribution is wide, extending over the Arctic and subarctic regions of North America, Europe and Asia. On the Restigouche it is found with the primrose, mosses, and other plants loving like situations, on wet rocks over which flow waters from cold springs. It has two-lipped flowers of a violet blue color borne singly on the top of slender scapes, about six inches high, which spring from the centre of a rosette of leaves of a yellowish-green color, which rest on the rock or ground. The margin of each leaf is turned upward forming a kind of trough, and the whole upper surface of the leaves is covered with minute glands, which secrete a kind of mucilage, entrapping midges and other small insects. Like our Sundew (*Drosera rotundifolia*), these glands are not stimulated to action by drops of rain or the pressure upon them of minute grains of mineral substance, but when an organic body, such as an insect, is brought in contact with them they are stimulated and pour forth, in addition to the mucilage, an acid secretion which has the power to dissolve animal substances, behaving exactly as does the gastric juice in the animal stomach, digesting the unfortunate insect that alights upon the leaves. In the *Drosera* the tentacles which are found upon the upper surface of the leaves in such abundance aid in capturing the insects. In *Pinguicula* the upturned edge of the leaf performs that office. If the insect attempts to crawl over this margin the edge curves over still further imprisoning the insect and pushing it toward the middle to bring it in contact with as many glands as possible. After absorption is accomplished, which usually occupies from twenty to thirty hours, the leaf expands again exposing the bleached remains of the insect, and setting a fresh trap for others. The leaves of *Pinguicula* are greasy to the touch hence its name from *pinguis*, fat. Its common name, Butterwort, is for the same reason.

A short distance below the Chain of Rocks we heard the sharp click of a mowing machine, a sign that we were approaching the outer world again and beyond was a small settlement (Mann Settlement) with further incontestable evidence of civilization — a school house. A short distance below was Deeside, a settlement which contains a church. On Green Island, near Deeside, we found growing in great abundance the Blood-root (*Sanguinaria Canadensis*) and the Pappoose-root (*Caulophyllum thalictroides*) another St. John River plant. Here too we found the Black Cherry (*Prunus serotina*). Soon we came to the mouth of the Upsalquitch with a fine club house, belonging to the Upsalquitch Salmon Club, fronting on the main river, and a little farther down a few yards below the mouth of the Upsalquitch is the fishing lodge of Dean Sage of Albany, the author of a finely illustrated book on the Restigouche.

Opposite the mouth of the Upsalquitch is the settlement of Runnymede, on a rich alluvial meadow, the joint tribute of the Upsalquitch and Restigouche.

But the last bend in the river brought into view a more imposing sight — the Squaw Cap Mountain and about two miles north of it and a little on our left, Slate Mountain. These twin peaks, the highest land along the Restigouche, rise to the height each of two thousand feet, or fully one thousand feet higher than the Sugar Loaf at Campbellton. It was half past two o'clock that day when we began the ascent of the Squaw Cap, and we were back again at half past seven — total distance ten miles, and some of that was hard climbing, but it was worth it. For three miles our course lay along Squaw Cap Brook, a clear stream whose ice cold waters were very grateful. Mr. Jas. Harris, whose farm is about a mile in from the Upsalquitch, was our guide. He showed us a part of his farm where the grass fields were completely covered by a weed whose presence has not been before noted in this province, a Hawkweed (*Hieracium prœaltum*). It is an ill favored plant about a foot high, hairy with yellow flowers in an open cyme, and a rosette of leaves which rest on the ground. So completely had these rosettes of leaves taken possession of the ground that every other form of vegetation was killed — even the grass. We had never seen a weed so completely master of the situation, and that is saying a great deal. Mr. Harris is almost in despair at the advances of this pest which threatens to cover his entire farm.

There was a wonderfully luxuriant flora along that wood road which led to the base of the Squaw Cap. The tall Joe Pye weed with its broad heads of ragged purple flowers towered above us fully eight to ten feet high; the Meadow-rue (*Thalictrum polygamum*) with its rich white and green flowers looked more delicately beautiful in this dense vegetation than ever before. Pyrolas covered the ground everywhere in those mossy woods with their racemes of nodding white or rose colored flowers. Orchids of brilliant hues grew so luxuriantly in those woods that we could imagine ourselves in tropical forests. But what is that orchid with the deep green leaves reticulated with white, and bearing a raceme of delicate brownish flowers? It was quickly gathered and consigned to the tin box, and proves to be an orchid new to the Province — *Goodyera Mensiezii*, making three of this beautiful genus found in

New Brunswick. We also found here *Goodyera pubescens* its second station in the Province. Our last half mile up the Squaw Cap was a most toilsome one, but our spirits were gladdened and refreshed by the clusters of rare ferns that grew in ringlets round this Cap—*Aspidium fragrans*, *Phegopteris calcarea*, *Woodsia glabella*, *Woodsia hyperborea*, all rare in this province and known only at one or two stations. These with other rare plants met with on the Restigouche I brought home and planted, and hope that next season I may have something better than these dried specimens to show you.

On the southern side of Squaw Cap Mountain we obtained a fine view of that great central watershed of the Province from which some single peaks rise, two thousand to two thousand five hundred feet above the level of the sea. There is easily picked out an old friend of former years — Bald Mountain on the Tobique, a trifle higher than the elevation on which we are now perched, tired and panting, but delighted. Away off to the southwest is the monarch of them all — Katahdin, in Maine, over five thousand feet high. From the north side the view is scarcely less imposing — the ranges and peaks of Quebec with the valley of the St. Lawrence beyond them. Just opposite to us, Slate Mountain, only three miles away, was wreathed in smiles of a rapidly descending sun, and beckoned us invitingly, but we turned regretfully away with many promises of a return which I hope will not lack fulfilment.

What a tramp that was! How tired we were! but when we looked over the treasures in the tin box, there was no weariness. We were delighted to see even a warden, and he looked curiously at our driers and press and the plants stowed away in them.

The river from the mouth of the Upsalquitch down is settled, and we soon come to the estuary, studded with islands, their alluvial soil rank with vegetation. On one of these islands—at the mouth of the Metapedia, we find the Maidenhair fern (*Adiantum pedatum*) and the Wild Ginger-root (*Asarum Canadense*). From Morissey's Rock we took a parting view of the Upper Restigouche, and a grand view it was. Here we found *Aspidium fragrans* again, *Woodsia hyperborea*, *Woodsia glabella* and near by *Pellæa gracilis* and the Small-flowered Anemone (*Anemone parviflora*).

SUMMARY.

We found eleven plants new to the province which are given in an appended list, with others rare or little known before. Of all our native orders the ferns seem to be of greater variety on the Restigouche than elsewhere in the province. The Leguminosæ family come next in abundance, then the Conifers the Rose family and the Compositæ. The Heath family is rarer in species here than anywhere else in the province. The presence of many alpine plants, especially near the mouths of rivers flowing in from the mountainous parts of south-eastern Quebec, is of interest.

LIST OF PLANTS NEW AND RARE.

Anemone parviflora, Mich.
A. multifida, DC.
A. cylindrica, Gray.
Viola primulæfolia, L.
Astragalus oroboides.
Oxytropis campestris, DC., var cærulea, Koch.
Lathyrus pratensis, L.
**Œnothera Oakesiana*, Robbins.
*Lonicera oblongifolia, Muhl
*Solidago Virgaurea L., var alpina, Bigel.
Gilia (Collomia) linearis, Nutt.
Cynoglossum Virginicum, L,
Pinguicula vulgaris, L.
Asarum Canadense, L.
Salix longifolia, Muhl.
Populus balsamifera, L., var. Candicans (?) Gray.
*Goodyera Menziesii, Lindl.
G. pubescens, R. Br.
*Sagittaria arifolia.
Carex atrata, L. var ovata, Boott.
*C. flava, L., var. graminis, Bailey.

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* Those marked * are new,

List of Plants New and Rare—*(Continued.)*

*Aster longifolius, Lam., var villicaulis, Gray.
*Hieracium præaltum, Vill.
Arctostaphylos Uva-ursi, Spreng.
Pyrola minor, L.
P. rotundifolia, L., var asarifolia.
*C. flava, L., var viridula, Bailey.
*Phleum alpinum, L.
*Equisetum littorale, Kuhlewein.
Pellæa gracilis, Hook.
Asplenium viride, Hudson.
Phegopteris calcarea, Fee.
Woodsia hyperborea, R. Br.
W. glabella, R. Br.

*** Those marked * are new.**

Dr. Matthew said that Mr. Hay's paper was the most important contribution to the botany of the province since Dr. Bailey's paper, descriptive of his trip up the Tobique and down the Nepisiguit in 1867. The area of country extending from the St. John River to the Restigouche and down the valley of that river, is a plateau country underlaid by Silurian slates, and through this the valley of the Restigouche has been cut. Owing to the considerable amount of lime in those slates they produce a fertile soil, for having been formed under the sea, they are rich in animal remains. The fact that they are thus calcareous, and that they are full of cleavage planes and cracks, highly inclined, helps to give them a natural drainage, and thus improve the capabilities of the country for farming purposes. The remnant of this plateau cut and carved by the Restigouche in past ages, now stands out along its lower courses as slate hills and ridges; but towards its mouth outbursts of igneous rock have further broken up the plateau and produced hills and ridges which are represented on the map of the Dominion Geological Survey by a bright red color. The absence of Heath plants, to which the writer of the above essay refers, is a good feature in the flora, as it indicates the absence of a barren, rocky and water-soaked country, such as these plants delight in. And notwithstanding the shortness of the season and the proximity of this plateau to a hill country on each side, it should contain considerable areas of good farming land, available for settlement.

Mr. S. W. Kain said that a number of the plants referred to in the paper were of a subarctic type—*Aspidium fragrans* especially. This taken in connection with the fact that the estuary of the Restigouche, and Bay Chaleur were frozen over early in the fall and only opened in May, would seem to show that further botanical exploration in this part of the province might result in the discovery of more plants of a northern character than are now recorded.

ARTICLE III.

AN OUTLINE OF PHYTOBIOLOGY. (PHYTOËCOLOGY.)

WITH SPECIAL REFERENCE TO THE STUDY OF ITS PROBLEMS BY LOCAL BOTANISTS AND SUGGESTIONS FOR A BIOLOGICAL SURVEY OF ACADIAN PLANTS.

BY W. F. GANONG.

The third paper of this series, dealing with "Adaptations of Plants to Reproduction, including Locomotion of Pollen," was presented to the Society on June 2nd, 1896. Since then, I have decided to withdraw it from publication, and for two reasons. First, I am convinced that it is the duty of this, as indeed of any local society, to give precedence in its publications to papers which make known the local natural history; and when means are scanty, as is, unfortunately for New Brunswick, the case with our Society, contributions of more general interest ought to give way. Second, conditions have changed greatly since I began this series four years ago. Then there was no work in English upon the subject, and no immediate prospect of any, and it had not received any unusual share of attention. Since then, Kerner's great "Pflanzenleben" has been translated into English,* important new works, together with very numerous special papers, have appeared in German, French and English, and there is great activity in this line of investigation. It is reasonably sure, moreover, that before long there will appear in English a concise work covering the present subject, and treating it in a not dissimilar way. It is now safe to say that long before this series could be completed upon its present lines, the necessity for it would be met by other works. Phytoëcology is at present the most attractive, most promising, and, from the educational standpoint at least, most useful division of the science, and the near future must see an immense development of knowledge in it and a wide application to education and to the pleasures of intellectual life.

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* The Natural History of Plants. Translated by Oliver. Edinburgh and New York. 4 vols.

It will be of interest to the readers of the earlier papers if I add here my latest plan for the completion of the series. The successive papers would have been,—

Introduction and Classification. *In Bulletin No. XII.*
A. Adaptations of Plants to Nutrition.
B. Adaptations of Plants to Growth.
C. Adaptations of Plants to Reproduction. *Read June 2nd.*
D. Adaptations of Plants to Response to Stimuli.
E. Adaptations of Plants to Locomotion. *In Bulletin No. XIII.*
F. Adaptations of Plants to Protection.
G. Artificial Classification and Key to adaptations, based upon size, shape, color, position, texture, etc.
H. Ecological Plant-geography of New Brunswick.

The third paper, *C. Adaptations to Reproduction*, as presented to the Society, treated the subject as follows:

PART I. PHYSIOLOGICAL ASPECTS OF REPRODUCTION. Fundamental meaning of Reproduction and of Sex: value of crossing in reproduction, and consequent advantage of locomotive arrangements to bring the sexual elements into contact. PART II. BIOLOGICAL (ECOLOGICAL) ASPECTS OF REPRODUCTION. *Section I.* Evolution of reproductive structures adapted to different external conditions: advance from lowest water to highest land habit. *Section II.*

Adaptations which effect locomotion of one reproductive body (male) to the other (female): problem in general similar to that of locomotion for spreading (treated in Bulletin XIII.), but in some ways more difficult: classification of possible and actually used principles of locomotion (compare Bulletin XIII., p. 7.): physical or climatic conditions under which plants live, and how these influence locomotion of the sexual elements: advance from free swimming Zoospores and antherozoids to locomotion by utilization of wind and animals, culminating in the flower, which is thus but a pollen-locomoting apparatus: full discussion of pollen-locomotion, often called cross-fertilization. *Section III.* Suggestions for study by local botanists.

I had intended to take up next *F. Adaptations to Protection*, including enemies and weather; next *D. Response to Stimuli*, the phenomena of Irritability which deal with individual adaptation to the outside world; next, *B. Growth*, including individual and race development; next, *A. Nutrition*, of greatest importance since it determines the very existence of leaf, stem and root; *G. the Key*, so arranged that one could, by observing a certain peculiarity of structure, size, form, etc., be referred to the preceding papers where its causes are discussed. Finally should come *H.*, the application of these principles to the study of the vegetation of Acadia and its geographical distribution.

Although for the reasons given, I discontinue the series as a whole, I propose to continue the investigation of the latter section, our ecological plant-geography, and my paper "Upon the Raised Peat Bogs of New Brunswick.," presented to the Royal Society of Canada in May last, and now being more fully elaborated, may be considered a first contribution to that undertaking.

These papers were addressed to the local botanists of Acadia; in concluding, I wish again to commend to them for study this subject of Plant-adaptation. All who wish to keep abreast of the advance of botanical science must give it careful attention. But those who would excel must do more; providing themselves with good books as guides, sharpening the powers of observation, reasoning and experiment, setting before themselves as the ideal the study of the plant alive, in action, and in touch with its surroundings, they must systematically, constantly and intensely devote to it their best powers.

Smith College, Northampton, Mass.,
December 12th, 1896.

ARTICLE IV.

NOTES ON THE NATURAL HISTORY AND PHYSIOGRAPHY OF NEW BRUNSWICK.

BY W. F. GANONG.

1. UPON REMARKABLE SOUNDS, LIKE GUN REPORTS, HEARD UPON OUR SOUTHERN COAST.

Read December 3rd, 1895; re-written December 24th, 1896.

Everybody who has been much upon our Charlotte County coast must remember that upon the still summer days when the heat hovers upon the ocean, what seem to be gun or even cannon reports are heard at intervals coming from seaward. The residents always say in answer to one's question: "Indians shooting porpoise off Grand Manan." This explanation I never believed; the sound of a gun report could not come so far, and besides the noise is of too deep and booming a character. I have often puzzled over the matter, and it is consequently with great pleasure that I find in "Nature" for October 31st, 1895, a short article by Professor G. H. Darwin, in which he calls attention to the occurrence of what is obviously the same phenomenon in the delta of the Ganges, upon the coast of Belgium and in parts of Scotland, and in which he asks for experiences from other parts of the world. Two explanations are suggested by his correspondent, M. Van den Broeck of Belgium, who called his attention to the phenomenon, one that the reports are of atmospheric origin, due to peculiar electrical discharges, the other that they are internal in the earth, due, perhaps, to shock of the internal liquid mass against the solid crust. The following number of "Nature," contains notes which suggest that the reports may accompany the formation of faults or may result from earthquakes too slight to be otherwise perceived, and later numbers of that Journal contain numerous letters upon strange sounds heard in different parts of the world, with various explanations.

The discussion upon the subject by this Society on December 3rd, 1895, has called out further information showing that others besides myself have noticed these or similar sounds in New Brunswick. The late Edward Jack, a keen observer of things in nature, wrote me under date December 13th, 1895,—"I have often noticed in Passamaquoddy Bay when I was duck shooting, in the early spring mornings, the noises of which you speak; they always seemed to come from the south side of the Bay. They resembled more the resonance from the falling of some heavy body into the water than that of the firing of a gun, such as is produced by a cake of ice breaking away from a large sheet of it and toppling over into the sea. These noises were heard by me only in very calm spring mornings when there was no breath of air . . . there was nothing subterranean in them." Captain Charles Bishop of the schooner "Susie Prescott," has told Mr. S. W. Kain that he has heard these sounds forty miles from land between Grand Manan, the Georges Banks and Mount Desert Rock. They are reported also from the Kennebecasis. Mr. Keith A. Barber, of Torryburn Cove, wrote December 26th, 1895, to this Society,—"I have heard sounds similar to those . . . on the Kennebecasis in the warm days of summer. They seemed to come from a southeasterly direction." Mr. Arthur Lordly, a member of this Society who resides in the summer at Riverside, has also told Mr. Kain that he has heard similar sounds, on clear warm days, on the Kennebecasis from a southwest direction. No other reports of this occurrence in New Brunswick have reached me. The *Scientific American* (June 27th, 1896, p. 403) has called attention to them and requested that observations be communicated to its columns, but apparently so far without result.

The latest opinion as to the origin of the sounds appears to favor an atmospheric origin, possibly connected with electrical disturbances. A very detailed circular, calling for exact observations, with series of questions and blank forms, has been issued by M. Van den Broeck of Brussels, who appears to have been the first to call scientific attention to them. It is very desirable since the sounds occur here, that they should be scientifically observed and recorded ; and it will be best to communicate the results to this Society, through which they will reach those who can make the best use of them. To secure the best results the following form, altered somewhat from M. Van den Broeck's circular, should be followed.

Name of observer.
Date of observation.
Exact place of observation.
Exact time of each observation.
Direction of the sound.
Character of the sound (full description with comparisons).
Wind, direction and velocity.
State of the sky.
State of the sea.
Mist conditions.
Barometer (state of the weather a few hours before and after).
Temperature.
Other remarks, including suggestions as to their origin, and reasons why they cannot be gun reports.

2. THE OUTLET-DELTA OF LAKE UTOPIA.

Read June 13th ; re-written December 22nd, 1896.

Lake Utopia is probably the most beautiful of New Brunswick lakes. It possesses several features of scientific interest, and among them one which must be rare, namely, a delta at its outlet. I cannot find any reference to this delta in any of our geological reports, nor do I remember reading of anything similar elsewhere. The lake empties into the Magaguadavic River by a thoroughfare, locally called "the Canal" which occupies a break in the rocky hills and is about two miles in length with a very uniform breadth. Where it leaves the lake, however, it is between two alluvial points which project nearly half a mile from the main shore. These points can be seen to be growing outward and the appearance is that of a delta at the mouth of a stream, though of reversed shape, and it looks strange enough at a lake outlet.

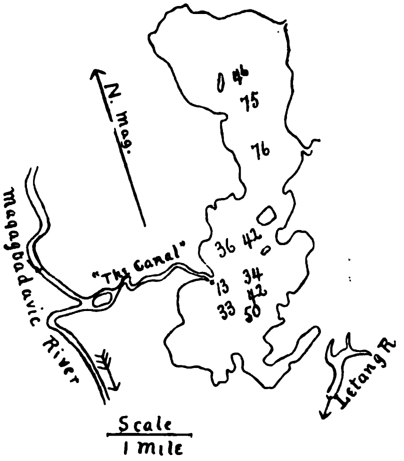

FIG. 1. Sketch map of Lake Utopia, in part after the 1797 survey map. Depths, in feet, from the latter map.

The points together form a triangle with its base against the mainland and the canal dividing it from the middle of the base to the apex. Their extreme points are very low and muddy and sink gradually under water to continue as shallows still farther out, but in one place they come to the surface again as a small marshy island, which, perhaps, marks the beginning of the splitting of the channel into two. The characteristic grass of the shallows is *Glyceria fluitans R. Br.* Farther in the land rises very gradually, the mud becomes firmer and bears a great deal of the small sedge. *Eleocharis tenuis*, *Schultes.* Here the bank is very steep on the canal side, near which

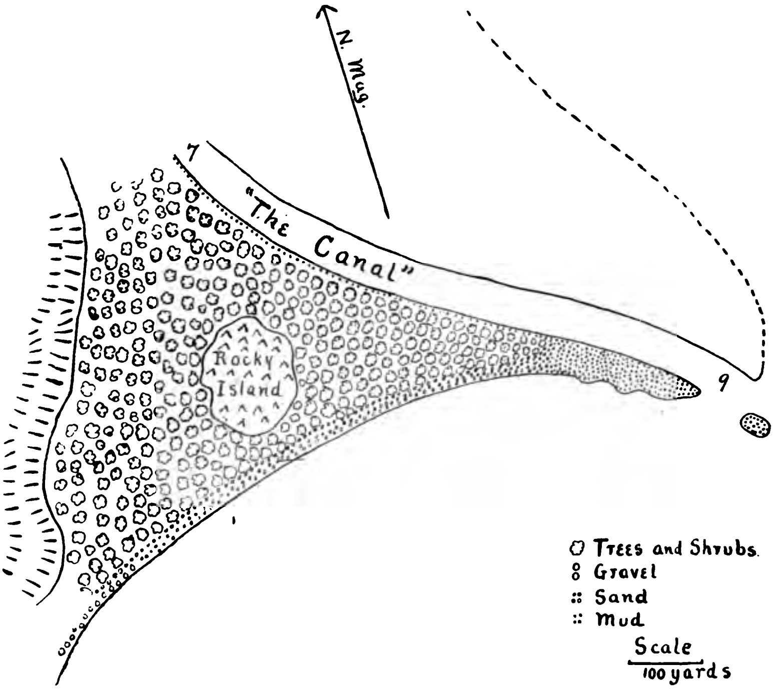

FIG. 2. Sketch map of the Delta. Depths from the 1797 survey map. Only the southern point was studied; the dotted line shows the probable outline of the northern point. The map is a mere sketch to illustrate points in the paper and topographically must be very inaccurate.

it is highest, but slopes off very gradually on the lake side, a characteristic of banks built up by the overflow of sediment-carrying streams. About two hundred yards from its apex, the southern point, the only one I was able to study, is forty to fifty yards broad, and here the sand, which is being gradually washed up by the lake over the mud, reaches the canal bank. Here low bushes appear and some forty yards further in the trees begin. After this the point broadens rapidly. Still further in is a dense alder swamp, from which arises in one place a high rocky island which has been surrounded by the delta in its growth. All along on the lake side is a splendid sand beach sweeping away in a grand curve to the main shore.

But the explanation of the presence and form of the delta is not difficult. It *is* at times at the mouth of a stream. The relation of the lake to the Magaguadavic River is peculiar, and happens to be so adjusted that at a certain height of water, both are on the same level and there is no movement through the thoroughfare. But, as the water rises after rains, it rises far more rapidly in the river than in the lake, which has but a small drainage basin, and pours into it through the thoroughfare. It then of course drops its sediment as it meets the still water, the chief requisite for delta-formation. As the water falls it flows out from the lake, but too gently to remove much of the sediment which has already settled to the bottom. It seems plain from the structure of the points, that the canal forms upon each side, by its sediment, only a bank of some forty to fifty yards broad, and that the remainder of the delta has been formed by the lake which is incessantly washing up sand, working it out along the lake-faces of the points and filling in the angles between them and the main shore. The very swampy character of the older parts of the delta is due of course to the prevention of drainage by the banks built up on the canal and lake sides. I could not determine the causes of the direction of the points and channel.

As the points are still growing it is fair to conclude that in time the delta will extend completely across the lake and divide it into two, a process which is known to have occurred in lakes elsewhere by the growth of the deltas of mountain torrents, but of which we have, I believe, no example in New Brunswick.

Mr. S. W. Kain has called the attention of the Society to the great shallows at the outlet to Grand Lake, Queens County, suggesting that they were formed in a similar way by sediment brought through the Jemseg. This is no doubt correct, but the conditions are here rather less remarkable, since Grand Lake, Jemseg and the St. John are but slightly separated parts of one former lake basin, while at Lake Utopia the river and lake are in separate rocky basins.

The points are not shown on the geological survey map nor on the corrected surface geology map, but they are plainly marked on the original survey map of 1796–'97, upon which also the depths of the lake are given. The thoroughfare near the lake is marked as seven feet deep, at the extreme points as nine feet, while a quarter of a mile further out it is only thirteen feet. But still further out the depths are thirty-three, forty-two and fifty feet, showing clearly that the delta is being pushed out into the lake. I could not myself, for lack of a boat, measure depths. Of course the delta is entirely post-glacial, because the lake is formed by the glacial dam between it and Letang. Possibly at one time the entire Magaguadavic River flowed by this route to the sea. If we could accurately measure the rate of growth of the delta, we would, by measuring also its size, be in possession of data for estimating how long ago the glacial period closed. Lake Utopia has, as I have said, other features of scientific interest, and I can imagine no more attractive problem than an exhaustive investigation of its hydrography, physiography and natural history.

New Brunswick thus possesses two reversible river phenomena — a fall at St. John and a lake inlet-outlet at Lake Utopia. The presence of these striking grassy points explains the significance of the name given by the Passamaquoddies to the lake, about which I had previously to my visit last summer been much puzzled. They call it *Mes-ke-qua-gum* which means "lake with grass (or bulrushes) around it," no doubt referring to this place; the name is altogether inappropriate elsewhere about it. Its English name was given by Governor Carleton when he found that the farms assigned to some of the Loyalists were under its waters — they were truly Utopian so far as any use to their owners was concerned.

3. Upon Temperature-Measurements with the Thermophone in Clear Lake, Lepreau.

(Read December 1, 1896.)

Clear Lake, Lepreau, is a gem in itself and a joy to the naturalist and physiographer. It lies at the west of St. John County, is about a third of a mile long and half as broad, of a shape shown in the accompanying map, and empties into Little Dipper Harbor. It occupies the upper end of a westerly-sloping trough formed between conglomerate rocks of Devonian age standing at high angle, and appears to be held in place by a glacial dam. Its level is very uniform, summer and winter, and its outlet is said to be constantly running, though it has no visible inlet. Its water is clear and its shores very clean, of rock, gravel and sand, with no mud. Its animal and plant life show some features of interest, worthy of more extended notice. It is noted for the immense trout it contains, a fact which I give from heresay, since my own numerous experiments upon this point yielded only negative results. It is locally reputed bottomless, but in the summer of 1895 Mr. S. W. Kain and I sounded it thoroughly and found its maximum depth to be seventy-eight feet; but this is a great depth for so small a lake. Its beaches, as a rule, slope down very suddenly, so that its average depth must be considerable.

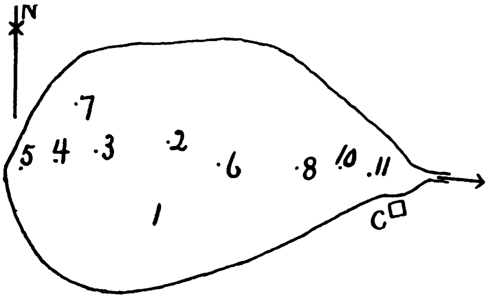

FIG. 1. Sketch map of Clear Lake. C = log camp. Scale about six inches to one mile.

Last summer I was enabled by the courtesy of Professor John T. Stoddard, of Smith College, Northampton, Mass., to bring to New Brunswick the Thermophone belonging to the department of physics in the college. By this instrument, recently invented, temperatures can be read at any distance and in any position to which a metal coil can be sent. Its principle cannot be explained* in a few words. I had expected to use it in my studies upon the temperature of raised peat bogs, but the temperature coil could not be thrust deeply enough into the bog to make it of use. It occurred to me, however, that by its aid I might be able to determine whether or not the constant flow from Clear Lake is due to the presence of springs. On July 1st, 1896, I went to the Lake with two companions and favored by good weather, made a series of temperature measurements, of which the results are given in the table. The stations, excepting a few trial ones, are shown upon the map (Fig. 1). I took the temperatures only for each yard of

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* It depends upon the fact that the electrical resistance of metals varies with temperature. Two pieces of (different) metals forming the "temperature coil" are connected up as a "Wheatstone Bridge." and so connected with a special battery and telephone that the latter hums while resistances are unequal and a current is passing through it. but becomes silent as a sliding contact equalizes the resistances, and a pointer then indicates upon a scale the temperature in the distant coil. The instrument is very accurate, and temperatures can be read it is said to .1°, though in a moving boat in a breeze about .25° is as close as one can read easily. It is made only by E. S. Ritchie & Sons, of Brookline, Mass.

Station No .		5	11	7	3	4	8	10	1	6	2	AVERAGE. 0
Depth in Feet,		19	24	32	45	46	46	60	72	72	73	0
DEPTH FROM SURFACE IN FEET.	3	65	65	65	65	65	65	65	65	65	65	65
	6	....	....	....	....	....	...	....	....	....	....	....
	9	....	....	....	....	....	....	....	65	....	...	65
	12	....	....	....	65	65	....	....	....	....	....	65
	15	64½	65	65	64½	64½	....	65	64	65	65	64 2-3
	18	63	65	63½	63	63	65	....	...	64½	64	63 7-8
	21	...	64½*	59½	59	59	59	....	....	59½	59½	59 1-4
	24	....	55½	55	54½	55	55	....	....	54½	53½	54 5-7
	27	....	....	50½	51	51	50½	....	....	51	50	50 2-3
	30	...	....	47	47½	48	48	47½	48	47	47½	47 9-16
	33	...	....	....	....	46½	46	....	....	46	....	46 1-6
	36	....	....	....	....	45	45	....	....	45	....	45
	39	....	....	....	...	44⅓	44½	....	....	44	....	44 1-3
	42	....	....	....	44½	44½	43½	....	....	44	....	44 1-8
	45	....	....	....	....	44	43½	43½	43½	43½	43½	43 7-12
	48	....	....	....	....	....	....	....	....	43½	....	43 1-2
	51	....	....	....	....	....	....	....	....	43	....	43
	54	....	...	....	....	....	.	....	....	43	....	43
	57	....	....	....	...	....	....	....	....	43	....	43
	60	....	....	....	....	....	...	42½	42½	43	42½	42 5-8
	63	....	....	....	....	....	....	....	....	42½	....	42 1-2
	66	....	....	....	....	....	....	....	....	....	....	....
	69	....	....	....	....	....	....	....	....	....	....	....
	72	....	....	....	....	....	....	....	42½	42½	42½	....

* Appears to be in error ; neglected in the average of this line.

depth and read only to half a degree; but it would have been far better, if time had allowed, to have taken them for every foot and for smaller fractions of a degree. In the diagram (Fig. 2) the results are shown graphically, bringing out clearly A, the absolute fall, and B the rate of fall in temperature at the different depths, and C the amount of vertical space occupied by each degree of temperature. The air temperature in the morning over the lake was 71° F.

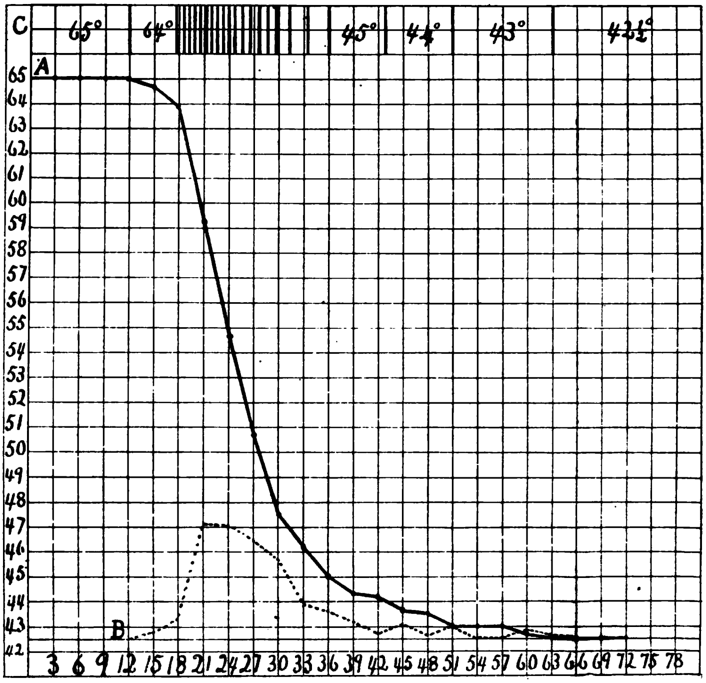

FIG. 2. Diagram of temperature in the lake.
Figures on abscissa (horizontal) = depths from surface in feet.
Figures on ordinate (vertical) = degrees Fahrenheit.
A = absolute drop in temperature. B = rate of drop at the different depths. C amount of vertical space occupied by each degree (approximate), obtained by extension from the points where the curve A crosses the temperature lines.
(The irregularities in the curves between 39 and 63 feet are of course due to the relative coarseness of the measurements. No doubt very minute measurements would give even curves. In curve B is a slight error in the drawing; on line 30 the point should be lower, and on 33 higher, so curve from 27 to 36 would be more even).

In synopsis the results are as follows:

1. For the first 12 feet there is no appreciable fall in temperature; from 12 to 18 feet there is a slight fall, $1\frac{1}{8}°$; at 18 feet a very abrupt fall begins and continues nearly evenly to 30 feet, and in these 12 feet it drops no less than $17\frac{7}{16}°$, or about $1\frac{1}{2}°$ per foot; below 30 feet the rate of fall diminishes until the minimum $42\frac{1}{2}°$ is reached at about 60 feet.

The meaning of these figures is no doubt this: that down to 12 feet the effect of the sun's light and heat is strongly and evenly felt, and the surface movements help to distribute it; after about 12 feet the heat has been largely absorbed, while at 18 it has been almost entirely taken up; the layers below that probably derive their temperature by conduction from those above them.

2. There are faint indications in the table that at depths below 30 feet the temperature near the bottom in the shallower places is slightly higher than at the same depths over deeper places, indicating that the ground slightly warms the water in contact with it, which is to be expected since it is a better conductor than water. But so slight are these indications that they may be neglected and it may be said, at least of the greater depths, that their *temperature is a function of distance from the surface* and bears no relation to the bottom.

3. The results give no positive information about the presence of springs.

It would have been of great interest had I been able later in the summer to make a second series to determine whether the average temperature of the lake was raised throughout, but this was not possible. I have not been able to compare the results obtained by others elsewhere, though with other instruments the subject has been much studied in Europe, and to some extent in America.

These results were not the product of a deliberately planned investigation, or they would have been far more minute and full, but were merely the gatherings of a holiday excursion.

As this paper is passing through the press I have had the opportunity, through Professor Stoddard's courtesy, to read an important article by the inventors of the Thermophone—"The Thermophone, a New Instrument for Determining Temperatures," by H. E. Warren and G. C. Whipple, in *Technology Quarterly*, for July, 1895. In this the inventors fully and clearly describe the instrument, and give in synopsis some of the results obtained by its use. My results, as far as they go, agree with theirs; but the latter show remarkable seasonal changes, and a distribution through the year which is determined largely by the different density of water at different temperatures, especially when near the freezing point.

ARTICLE V.

NOTES ON THE OCCURRENCE OF TWO SHREWS NEW TO NEW BRUNSWICK.

BY PHILIP COX. A. B , B. Sc., Ph. D.

Read May 5th, 1896.

In Bulletin No. X., 1892, reprinted from No. III, 1884, Mr. Montague Chamberlain records two shrews from the province,— the Common Shrew, *Sorex platyrhinus*, and the Western Shrew, *S. cooperi.* Though what are now regarded as two distinct forms were designated *platyrhinus*, the first by Prof. Baird (Mammals of N. A. 1857), the *Otisorex platyrhinus* of De Kay (New York Mammalia, 1842); and the second by Dr. Dobson (Monog. Insectivora, 1890), it would seem that the animal referred to in the list is that of Baird's description, as the other, now designated *S. fumeus* Miller (North American Fauna, 1895) is exceedingly rare, and had not been recognized as a distinct species when Dr. Jordan published his Manual of Vertebrates, whose classification and nomenclature Mr. Chamberlain says he adopted. Moreover, the latter describes the animal as "common," a term best applicable to Baird's *platyrhinus* which is the most abundant in the province. It is, too, exceedingly variable, and well deserves the name "*personatus*" bestowed on it by Geoffroy Saint Hilaire early in the century, which on grounds of priority is its specific designation at present.

In a recent monograph on the shrews of North America, Dr. C. Hart Merriam maintains the specific identity of *S. cooperi* Bachman, and *S. personatus*; and hence the former name becomes a synonym of the latter.

The writer has lately collected Richardson's Shrew, *S. richardsoni* Bachman, a robust boreal form fairly common in the northwest and northern part of the Central Plain, its known range, with the exception of northern Minnesota, being entirely Canadian. Its occurrence on the Atlantic seaboard, nearly two thousand miles away, is the most striking example of discontinuity in the distribution of any known mammal, far exceeding that of the Varying Hare of Europe. When the Canadian fauna comes to be more thoroughly investigated, this species will probably be found more or less distribnted over the immense stretch of continent now forming such a strange break in its distribution. It is quite common on the intervals and low wooded lands adjacent to the St. John in Maugerville, Sunbury County.

I am not aware that *S. fumeus* Miller has ever been recorded from the province, its nearest locality being New Hampshire. In February, 1895, the writer took a single specimen in coniferous woods in the parish of Maugerville. It is of a uniform dark slate color with a tail longer than is usual in members of the genus. It is a sub-boreal form frequenting southward the upper portions of mountains; and does not seem to have had any previous Canadian record. It is very rare.

APPENDIX.

REPORT ON ZOOLOGY.

BY PHILIP COX, PH. D.

(Read May 5th, 1896.)

The Committee have to record the following additions to the Fauna of New Brunswick:

MAMMALS.

Evotomys fuscidorsalis Miller. Locality, Tobique. New to science. J. A. Allen, New York.

E. gapperi Vigors. Red-backed Mouse. Locality, Maugerville, Cox.

Sorex thompsoni Baird. Thompson's Shrew. N. B. Dr. Bailey.

S. richardsoni Bachman. Richardson's Shrew. Locality, Maugerville. Cox.

S. fumeus Miller. Locality, Maugerville. Cox.

Putorius noveboracensis DeKay. American Ermine. Locality, Sunbury Co. Cox.

RECENT ADDITIONS TO THE LIST OF NEW BRUNSWICK FISHES.

Liparis lineata Kröyer. Sea Snail. Taken at North Head, Grand Manan, by Mr. Moses, and donated to the Natural History Society of New Brunswick by Messrs. Patterson and A. McLean. A deep sea fish ranging from the polar regions to Cape Cod.

Maurolicus borealis Gunther. Argentine. Found dead on the sea-shore at the same place and by the same person, and donated by the above named gentlemen. A small pelagic fish, with opercular apparatus incomplete, and skeleton scarcely ossified; of a bright silvery appearance, with the inferior parts thickly studded with phosphorescent spots. The only Canadian record known to the writer.

BIBLIOGRAPHY OF SCIENTIFIC PUBLICATIONS RELATING TO THE PROVINCE OF NEW BRUNSWICK OTHER THAN THOSE CONTAINED IN THE BULLETINS OF THE SOCIETY, 1896.

BY SAMUEL W. KAIN.

As stated in Bulletin XIII., it is proposed to publish each year the titles of all works, other than those contained in the Bulletins themselves, relating to New Brunswick, on the subjects coming within the scope of the Society's work.

The list published in Bulletin XIII. contained titles from 1890 to 1895. The present list contains titles from December 1895 to December 1896.

GEOLOGY.

MATTHEW, G. F.—Traces of the Ordovician System on the Atlantic Coast. *Trans. Royal Society of Canada, Vol. I. (2nd Series), Sec. iv., pp.* 253–271, *pl.* 2. 1895.

Organic Remains of the Little River Group. *No. IV. Ibid., pp.* 273–279, 5 illustrations. 1895.

Notes on Cambrian Faunas—the Genus Microdiscus. *Am. Geologist, Vol. XVIII., No.* 1, *pp.* 29–31. July, 1896.

Faunas of the Paradoxides Beds in Eastern North America. No. 1. *Trans. New York Academy of Sciences, Vol. XV., Sig.* 12, *pp.* 192–247, 4 *pl.* August 3, 1896.

On the Occurrence of Cirripedes in the Cambrian Rocks of North America. *Ibid., pp.* 137–140, 2 figures. 1896.

PHYSIOGRAPHY.

DAWSON, W. BELL.—Note on Secondary Undulations Recorded on the Self-recording Tide Gauges; and on Exceptional Tides in Relation to Wind and Barometer. *Trans. Royal Society of Canada, Vol. I. (2nd Series), Sec. iii., pp.* 25–26, 2 drawings. 1895. (Refers to secondary undulations at St. John, N. B.)

GANONG, W. F.—The Outlet Delta of Lake Utopia. *Progress, June* 13, 1896. (Reprinted, Leaflet, 3 *pp.*)

REYNOLDS, W. K.—Recording the Tides (at St. John, N. B.) The *Daily Telegraph, St. John, N. B., October* 28–30, 1896. (A popular account of the tides at St. John, explaining purpose of the tide gauge, position of the "bench mark" and amplitude of the harbor tides.)

METEOROLOGY.

GANONG, W. F.—Remarkable Sounds (from the Bay of Fundy). *Nature, Vol. LIII.*, 101. December 5, 1895.

Upon the Gun Reports Heard Upon Our Southern Coast. (Note.) *St. John Daily Sun, December* 7, 1895.

"Barisal Guns" and "Mist Pouffers." *Scientific American, Vol. LXXIV., No.* 26, *June* 27, 1896. (Refers to Prof. Ganong's Observations.)

BOTANY.

JACK, I ALLEN—Our Wild Flowers, 20 *pp.* St. John, N. B., 1896. (Reprinted from a series of papers published in the *Daily Sun.*)

ZOOLOGY.

BAIRD, FRANK—The Moose of Eastern Canada. *Gameland, Vol. IX., No.* 5, *pp.* 135–189. October, 1896.

GANONG, W. F.—Do Young Loons Eat Fresh Water Clams? *The Auk, Vol. XIII., pp.* 77–78. January, 1896.

PRINCE, E. E. The Sardine Fishing Industry in New Brunswick. *Special Report of Commissioner of Fisheries, Part III.* Ottawa, 1896.

SHEWEN, E. T. P.—Teredo Notes. *Report of the Minister of Public Works (Canada), for* 1895, *pp.* 245–250. Ottawa, 1896.

VANWART, ROY McL.—New Brunswick Woodpeckers. *University Monthly (Fredericton, N. B.), Vol. XVI., No.* 1, *pp.* 8–9. October, 1896.

Frogs (of New Brunswick). *Ibid., Vol. XVI., No.* 2, *pp.* 35–36. November, 1896.

THIRTY-FOURTH ANNUAL REPORT

OF THE

COUNCIL OF THE NATURAL HISTORY SOCIETY

OF NEW BRUNSWICK.

The Council of the Natural History Society beg leave to submit the following report for the year now ending :

MEMBERSHIP.

There has been no important change in the membership, but it is highly desirable that the roll should be much enlarged. Additions are noted as follows :

Ordinary Members	5
Associate Members	6
Corresponding Members	4
Total increase	15

During the year two of our members have been removed by death.

Edwin Fisher died on July 11th, 1895. He was for many years a member of the Council and a well remembered attendant at the meetings of the Society.

Edward Jack, C. E., died on December 31st, 1895, at Fredericton. He was for many years a corresponding member of the Society, and was a recognized authority on the forestry and natural resources of this province. In his library, now in possession of D. R. Jack, Esq., of this city, is a large collection of note-books, lectures and newspaper articles, containing much relating to the early history of this province, as well as a great fund of information in regard to the forests, moors, lakes and streams that he knew so well.

FINANCE.

The report of the Treasurer shows a small surplus of receipts over expenditures:

Balance from last year	$ 52 31
Dues collected	84 00
Government grant	125 00
Interest on investment	144 00
Other items	31 30
	$436 61
Current expenses	374 87
Balance	$61 74

LECTURES AND ESSAYS.

During the year eleven meetings of the Society were held, at which the following papers were read:

1895.

Jan. 15 Recent Discoveries in the Pre-cambrian Rocks of Brittany. Annual address of President, Geo. F. Matthew.

Feb. 5 The Geological History of the Vertebrates. Philip Cox, Ph. D.

March 4 The Eskimo and his Origin. H. G. Addy, M. D.

19 Teredo Notes. By E. T. P. Shewen, C. E. Published in Report of Public Works Department of Canada, pp. 245-250, 1896.

April 2 (1) The Outlets of the River St. John. By Robert Chalmers,

(2) Points in the Geology of the St. John River Valley. By Professor L. W. Bailey.

May 7 The Volcanic Rocks of the Maritime Provinces. By Wm. D. Matthew. (Published in Bulletin XIII, 1895).

June 4 The Adaptations of Plants to Locomotion. By W. F. Ganong. (Published in Bulletin XIII, 1895).

Oct. 9 Report on Summer Camp held at Lepreau. By Geo. F. Matthew, Geo. U. Hay and W. F. Ganong. (Published in Bulletin XIII, 1895).

Nov. 5 (1) The Chemical and Microscopical Examination of Blood. By W. F. Best.

(2) The Unsuitability of the Bay of Fundy for Oyster Culture. By Samuel W. Kain.

Dec. 3 Egypt and the Monuments. By Mrs. Emma Fiske.

1896.

Jan. 7 (1) Trinidad. By J. V. Ellis, Jr.

(2) Note on the Occurrence of the Long Billed Marsh Wren near St. John. By John Brittain.

(3) Note upon the "Gun Reports" heard upon our southern coast. By W. F. Ganong.

The following course of elementary lectures was given :

1895.

Jan. and Feb.	Geological History of the Invertebrates. By Geo. F. Matthew.
March.	Geological History of the Vertebrates. By Philip Cox.
April.	Classification. By W. M. McLean.
May.	Spring Plants. By Geo. U. Hay.

LIBRARY.

The Library shows a considerable increase. Two donations of a large number of books and pamphlets were received from Dr. Matthew and Mr. Hay. Cards have lately been procured to be used in making a catalogue.

BOTANY.

The report of the Botanical Committee for 1895 is contained in Bulletin No. XIII.

A valuable addition to the museum in this department is the collection of about 1,000 plants, presented by Prof. Fowler. These are the plants described in the list of our flora given in Bulletin IV.

MUSEUM.

The collection of mollusca has been cleaned, arranged and catalogued. This is an important work, as the shells were previously in an unsatisfactory condition. Numbers corresponding to those in the catalogue need to be fastened to many of the specimens, by which they could be permanently identified.

The cases in the invertebrate room, containing corals, shells and crustacea, have been made dust proof.

We should notice Dr. W. F. Ganong's donation of the remainder of his collection of invertebrates of the Bay of Fundy, consisting chiefly of the rare and critical species.

Dr. Cox, of the Dominion Fisheries Department, spent some weeks in the museum, making use of the library and specimens in connection with his official work.

PUBLICATIONS.

Bulletin No. XIII has just been issued. It is larger than usual and will be found to contain much of local interest. Chiefly to be noticed is Dr. Cox's article on the New Brunswick fishes, giving a list of the species, which will be of much economic, as well as scientific value.

SUMMER CAMP.

The Summer Camp of 1895 was held at Lepreau Basin, in July. It was attended by thirty members, and others, and was very successful. Among those present were Dr. Bailey and Professors W. F. Ganong and A. W. Duff. An account will be found on page 89 of Bulletin No. XIII.

GENERAL.

The Room Committee have made several changes in the heating arrangements. A stove has been placed in the invertebrate room, and a new one obtained for the lecture room. A great improvement has been made in the appearance and accommodation of the library, by a large new case, which gives room for a proper arrangement of the books and periodicals.

The visitor's book shows that a large number of persons have visited the museum during the year and examined the collections.

We all wish for the time when an attractive building, with ample room for a well arranged museum, will continue to be a place of interest for all visitors to the city, as well as for the citizens themselves.

To those who prepared the many interesting papers and lectures heard during the past year, the thanks of the Society are due; as also to the press for the insertion of notices and reports of meetings.

Respectfully submitted,
GEOFFREY STEAD.
Secretary to Council.

DONATIONS TO THE LIBRARY, 1895.

DONOR'S NAME.	RESIDENCE.	WORK.
Royal Society	London	Proceedings.
Royal Colonial Institute	do	Journal
Geological Society	do	Abs of Proceedings.
Director Royal Gardens	Kew	Bulletins.
Manchester Geological Society	Manchester	Proceed. and Trans.
Biological Society	Liverpool	do
Liverpool Geological Society	do	do
Marine Biological Association	Plymouth	Journal.
Belfast Naturalists' Field Club	Belfast	Ann. Rep't and Proc.
Royal Society of Canada	Ottawa	Proceed. and Trans.
Ottawa Field Naturalists' Club	do	Ottawa Naturalist.
Department Inland Revenue	do	Bulletins.
Entomological Society of Ontario	London, Ont	Can. Entomologist
Hamilton Association	Hamilton	Journal.
Natural History Society	Montreal	Can. Record of Scien.
Sir Wm. Dawson	do	Pamphlets.
Historical and Scientific Society of Manitoba	Winnipeg	Report.
Nova Scotia Institute of Natural Sciences	Halifax	Proceedings.
University of Toronto	Toronto	Quarterly.
Geo. F. Matthew	St. John	Reports on Geology of Italy, Georgia (U. S A.), and Minnesota; also 25 pamphlets on geological subjects.
Geo. U. Hay	do	Canadian Scientist, Nos 1-11 (1885), Acadian Scientist, 1883-1884, Botanical Notes, by W. T. L. Reed (MSS.), and 175 pamphlets, mostly relating to botany.
John V. Ellis, Jr	do	Proceed. of Victoria Instit'e of Trinidad
Australian Museum	Sydney, N.S.W.	Report.
Australian Assoc. for Advancement of Science	do	Report, Vol. V.
Linnean Society of N. S. W	Elizabeth Bay	Proceedings.
New Zealand Institute	Wellington, N Z	Proceed. and Trans. Vol. XXVII
U. S. Geological Survey	Washington	Reports and Bulletins
U. S. Fish Commission	do	do
U S. National Museum	do	Reports and Proc.
U. S. Dep't of Agriculture (Botanical Division)	do	Bulletins.
U. S. Coast and Geodetic Survey	do	Report.
Smithsonian Institution	do	do.
University of California	Berkeley, Cal.	Bulletins.
University of Michigan	Ann Arbor	Report.
Cornell University	Ithaca, N. Y.	Bulletins.
Tufts' College	Tuft's Col, Mass	Studies.
Johns Hopkins University	Baltimore	Circulars.
Boston Society of Natural History	Boston	Proceedings.
Essex Institute	Salem	Bulletins.
New York Academy of Sciences	New York	Transactions.
New York Microscopical Society	do	Journal.
Linnean Society of New York	do	Abstract of Proceed.
American Museum of Natural History	do	Report.
Linnean Society of New York	do	Abstract of Proceed.

DONATIONS TO THE LIBRARY—*(Continued)*.

DONOR'S NAME.	RESIDENCE.	WORK.
Natural Science Association of Staten Island..	New Brighton.	Proceedings.
Rochester Academy of Natural Sciences	Rochester, N.Y.	do
Iowa Academy of Sciences	DesMoines.....	do
Academy of Natural Sciences,...............	Tacoma	do
Colorado Scientific Society	Denver	do
Cincinnati Society of Natural History.	Cincinnati......	Journal.
C. G. Lloyd	do	Plates.
Missouri Botanical Garden	St. Louis	Annual Report.
Prof. J. Walter Fewkes.......	Boston	Pamphlets.
Field Columbian Museum......................	Chicago	Publications.
Comite Geologique du Russie,..................	St. Petersb'g. .	Memoirs and Bul'tins
Imperial Academy of Sciences.......	do ..	Bulletins.
Geological Institute of Upsala.	Upsala	do

PURCHASED.

Among Rhode Island Wild Flowers. By Prof. W. W. Bailey.

DONATIONS TO THE MUSEUM.

Date.	Donor's Name and Description of Article.
1895. *Mar.*	Mrs. John S. Maclaren. Collection of Plaster Medallions in a Case.
	E. T. P. Shewen, Esq., C. E. Two Pieces of Timber from Cape Tormentine, bored by *Teredo navalis.*
	F. S. Thompson, Esq 75 Specimens of Tropical Shells.
Apl.	Geo. D. Bain, Esq. Cluster of Spawn of the Conch Shell. Sea Ivory. Pod of *Ponciana Regia.* From South Coast of Florida.
	James Kelly, Esq. Young Eagle, Mounted. Captured at Bocabec Lake.
	W. M. McLean, Esq. Dollar Fish (*Stromateus triacanthus*), from St. John Harbor. *Hemetripterus Americanus*, "Sea Raven," St. John Harbor.
	Dr. John Baxter, Chatham, N. B. Piece of Whalebone taken from mouth of a whale thrown on shore at Neguac, N. B.
July	Dr. William F. Ganong. Dredge Net and Dip Net, the Outfit used by Dr. Ganong during his investigation of The Marine Fauna of the Bay of Fundy.
Aug.	Geoffrey Stead, Esq., C. E. Fifty-seven Species Miocene Fossils from Maryland and Virginia, U. S. A. Staurolite Crystals, from Shelburne, N. S. Plant and Insect remains from peaty layer in clay at Lee's Brickyard, Courtenay Bay. *Ctenodiscus adspersus,* young specimen of the Cunner or Blue Perch, from the "North Shore" of New Brunswick.

DONATIONS TO THE MUSEUM—*(Continued.)*

Date.	**DONOR'S NAME AND DESCRIPTION OF ARTICLE**
1895.	DR. P. COX AND G. STEAD, ESQ., C. E. *Gammarus ornatus, Edm.*, Courtenay Bay, St. John.
Nov.	ROBERT MATTHEW, ESQ. Quartz Arrow Point, changed to Skin Scraper, and Flake of Carnelian, from Indian Camping Ground, Washademoak Lake. Pod of Locust Tree ("Flamboyant"), Trinidad Cuba.
	JOHN V. ELLIS, JR., ESQ. Bird Nests from British Guiana, and Snake Skin and Mounted Frog from Trinidad. Rolled Pebbles of Asphalt and Commercial Asphalt, Trinidad.
Nov.	W. F. BEST, ESQ. 9 Species of Sea Shells.
Dec.	DR. MCINERNEY, St. John, N. B. Flying Fish (*Exocœtus rondeletii*), Scorpion (*Chelifer Wideri*), West Indies.
	PROF. JAMES FOWLER, Queen's College, Kingston, Ont. Collection of Plants, about 1,000 specimens, being the type specimens of the N. B. list (Bulletin No. IV.)
	G. U. HAY, ESQ. Minerals from Blomidon, N. S.

OFFICERS AND COMMITTEES OF THE NATURAL HISTORY SOCIETY FOR 1896.

Patron—His Honor the Lieutenant Governor, Honorable John James Fraser.

COUNCIL FOR 1896.

President—Geo. U. Hay, M. A., F. R. S. C.
Vice-Presidents—Wm. Murdoch, C. E., H. G. Addy, M. D.
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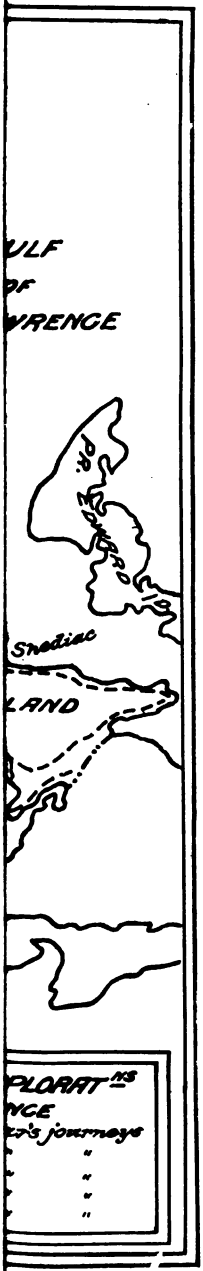
Curators—F. E. Holman, J. V. Ellis, Jr., Thos. Stothart.
Librarian—G. Stead, B. A.
Additional Members—Geo. F. Matthew, D. Sc., F. R. S. C., Gen. D. B. Warner, J. Roy Campbell.
Delegate to Royal Society—William J. Wilson.

ASSOCIATE MEMBERS' BRANCH.

President—Mrs. Geo. F. Matthew.
Secretary-Treasurer—Mrs. F. E. Holman.

STANDING COMMITTEES FOR 1896.

Physics—Wm. Murdoch, W. F. Best, A. Lordly.
Geology—Geo. F. Matthew, L. W. Bailey, J. P. Clayton.
Invertebrates—Geo. F. Matthew, G. Stead, S. W. Kain.
Vertebrates—H. G. Addy, W. W. White, P. R. Inches.
Botany—Geo. U. Hay, James Vroom, H. F. Perkins.
Lectures—Geo. U. Hay, H. G. Addy, J. Roy Campbell, J. V. Ellis, Jr., S. W. Kain.
Archæology—Geo. F. Matthew, F. E. Holman, S. W. Kain.
Publications—Geo. F. Matthew, Geo. U. Hay, S. W. Kain, A. Seely, P. G. Hall.
Rooms—H. G. Addy, Geo. F. Matthew, Wm. Murdoch, J. E. Wilson.
Press—P. G. Hall, J. V. Ellis, Jr.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BULLETIN

OF THE

NATURAL HISTORY SOCIETY

OF

NEW BRUNSWICK.

No. XV.

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1897.

BULLETIN
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NATURAL HISTORY SOCIETY
OF
NEW BRUNSWICK.

ARTICLE I.

ABRAHAM GESNER.
A REVIEW OF HIS SCIENTIFC WORK.

BY G. F. MATTHEW, D. Sc., F. R. S. C.

Read November 1st, 1892.

About half a century ago the name of Abraham Gesner became widely spread in the Maritime Provinces of Canada, from his efforts to make known the mineral wealth and great natural resources of his native province of Nova Scotia; and from his zeal in proclaiming the truths of the new science of Geology.

Born in the midst of a district famed for its natural beauty and its fertility—the land of Evangeline—he was within easy reach of some of the most prolific mineral localities, and some of the most remarkable natural geological sections to be seen in the Maritime provinces of Canada. It is not surprising, therefore, that he should have been filled with enthusiasm for the new science, and should have endeavored by tongue and pen to make known the natural wealth of the Acadian land.

A knowledge of the early life and character of Gesner will naturally be sought for by those who are interested in his scientific work. Fortunately this has been supplied by his surviving sons, now living in New York; and a biographical sketch of his father written by G. W. Gesner has been published in the fourteenth Bulletin of this Society (1896).

The following sketch of Dr. Gesner's scientific work was read before this society some years ago but was held over from publication, awaiting a more detailed account of his early life and education than was then available. This account has been furnished by the Messrs. Gesner in the sketch of his career given in Bulletin No. XIV, and to this will naturally succeed the account of his literary labors.

GEOLOGY AND MINERALOGY OF NOVA SCOTIA.

The earliest important work of Dr. Gesner of which the writer has any knowledge is one on the Geology and Mineralogy of Nova Scotia published in 1836.*

In the preface to this work, Dr. Gesner claims for Nova Scotia that abundance of useful and important minerals which she has since been shown to possess, and this at a time when her coal industry was in its infancy, and her gold mines unknown; and he says that she will maintain her pre-eminence in this respect unrivalled by any country of equal size.

The author tells us that this work was written for the "perusal of the general reader," and in accordance with this intention it is prefaced with a short introduction to the science of geology and mineralogy, drawn from the works of eminent writers of the first half of the present century. Among the writers frequently quoted in this book are Mohs, Brongniart, Buckland, Cuvier, Lyell and Cleveland. An outline such as Dr. Gesner gave was the more necessary in those days because scientific text-books on the science of Geology were few, and difficult of access in a new country.

Gesner acknowledges receiving some information from the writings of Messrs. Jackson and Alger, two Boston chemists, and from Mr. Haliburton's history of Nova Scotia. On comparison with the work of the two former the reader will perceive that Dr. Gesner has drawn largely for information from this source, but at the same time he does not show a slavish adherence to the opinions of these authors.

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* **Remarks on the Geology and Mineralogy of Nova Scotia by Abraham Gesner, Surgeon, 313 pp., 2 pl., 1 map. Halifax 1836.**

The essay of Messrs. Jackson and Alger* was written in 1831, and gave the first full and accurate account, that had been published, of the minerals of the "North Mountain" of Nova Scotia. In connection with the principal topic of their work they gave also an outline of the geology of the province as a whole.

Considering the time at which it was written, this work was an excellent digest of information on the minerals of Nova Scotia, but it was too technical for the ordinary reader, and Gesner's book, written in a more popular style, and from the stand-point of the colonist, had a wider circulation, and served to diffuse more generally among the provincials a knowledge of the resources of Nova Scotia.

Gesner found four geological districts in the province, these he called the Primary District, the Clay Slate District, the Red Sandstone District and the Trap District.

A division into four districts had been adapted by Messrs. Jackson and Alger, but while Gesner classed all the red sandstones together, the above authors, on their map, distinguished the red sandstones of the Annapolis valley from the others and described them in connection with the trap rocks—a more natural arrangement.

Of the *primary district* extending along the Atlantic coast from Canso to Shelburne, Dr. Gesner observed that the "clay slate" succeeded the granite, except where the gneiss and mica schist are interposed. He thus recognized the antiquity of the slates of this tract as contrasted with those of the district next to be described. How little the mineral wealth of this district was suspected at this time, may be gathered from another remark wherein he says (in speaking of the country east of Halifax) that no indications of ores were seen on any part of this coast.

In the country west of Halifax Dr. Gesner found a variety of quartzites, mica schists and clay slates, with hills and masses of granite interspersed. He lays special stress on the rocking

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*** Remarks on the Mineralogy and Geology of Nova Scotia by Chas. T. Jackson and Francis Alger. Published by the American Academy of Science, 1831.**

stones and perched boulders observed in this district, as curious objects of much interest. In this district also he found deep fissures in the granite, and supposes that there have been violent earthquakes and volcanic explosions, which had rent the rocks asunder and thrown these boulders to the tops of the highest hills.

This primary district of Dr. Gesner corresponds to the quartz-rock and slate district of Messrs. Jackson and Alger, but the boundaries given by Gesner are more natural than those of the Boston authors. Also it corresponds to the Lower Silurian of Sir Wm. Dawson's map* but is much narrower.

In his account of the second, or *Clay slate district*, Dr. Gesner, while remarking upon the occurrence of granite, gneiss and mica schist in this district, found it to contain also graywacke and the "old mountain limestone" with remains of marine animals and plants. The boundaries of this district as given by Gesner nearly correspond with those of the "Transition" clay slate of Messrs. Jackson and Alger, but where they differ Gesner's boundaries are more correct and natural.

Gesner's description of the iron ores of Clements and Nictau also agree very nearly with that of the authors above named, and both also describe in somewhat similar terms the fine quartz crystals of Paradise river and the bog iron ore of Aylesford.

There is a difference in condition between the iron ores of Clements and Nictau, for while the former are converted into magnetite, the latter are still hematitic ores. The Boston chemists thought the alteration of the Clements ore due to heat from the mass of trap in the North Mountains on the opposite side of the Annapolis valley; Gesner on the contrary attributed it to the vicinity of intrusive granite.

An interesting account is given by Dr. Gesner of the discovery of a fossil of the zoophyte family† and of dendritic markings in the grey slates at Beech Hill in Horton. Fossils (encrinites and trilobites) were also discovered in the clay slate formation at New Canaan. Several pages are devoted to a description of the iron ore beds of the Pictou district, which also had attracted the attention of Messrs. Jackson and Alger.

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*In Acadian Geology. 2nd Ed. London 1868.

† Now known as *Dictyonema Websteri.*

In explaining the transportation of large masses of rock in this district which are found far removed from their parent beds, and are found on the surface of the newer rocks or promiscuously scattered over the ground, Dr. Gesner invokes the aid of powerful currents. From his further remarks it is evident that he supposed these currents to have been ocean currents and to have been those of a general deluge.

All the western part of this district is spoken of as the South Mountain, and the rocks are said to be generally of transition age, and are "among the most ancient of the secondary strata."

This slate district, both as defined by Gesner and by the two Boston authors, comprises the Silurian and Devonian rocks of the province,* (except such as appear in the Cobequid range) and the interior or northern part of the Cambrian belt of the Atlantic coast.

In the sheltered and fertile valley of Annapolis, Dr. Gesner found the new red sandstone, a comparatively recent deposit, and inferred that the red sandstones to the northeast of it were of the same age. Hence he described all the northern area of Nova Scotia as the *Sandstone district.* In this district the soils are more fertile than in other parts of the province, and Dr. Gesner had a high opinion of its marl as a fertilizer. He does not fail to describe the extensive desposits of limestone, gypsum and calcareous marl which are formed here. The extensive tracts of marine alluvium formed in the northern part of Nova Scotia are said to be laid down on these red sandstone rocks.

The account given of the Wilmot spring is an interesting bit of local history, in view of the extensive use now being made of its waters:—

"In the town of Wilmot, about three miles from Gibbon's Inn, there is a mineral spring possessing medicinal properties of considerable importance. When the discovery was first announced to the public, numerous were the persons who, being afflicted with different diseases, hastened to the waters, then supposed to be the *elixar vitæ* and quite sufficient to remove all the ills that flesh is heir to. Without reference to the nature of their diseases, and at every stage of their complaints they hoped and vainly hoped to obtain relief. In the midst of the forest the little village near the pool of this modern Bethesda was all bustle and confusion, while many for want of accommodation were obliged to depart not healed. * * * Many were the cures reported to have been made at this spring. Newspapers teemed with its praises. But experience soon proved that its powers were not sufficient to remove all the ailments of its visitors; hence Wilmot spring is already abandoned and its name is seldom spoken. So changeable and unsteady is public opinion." * * *

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* In a work written thirteen years later Gesner classes these slates as Silurian.

"The waters of the spring have been analyzed by Dr. Webster and are found to contain sodium, lime, sulphuric acid and magnesia. They will doubtless be beneficial in all scrophulous and glandular diseases. They are generally aperient and cannot fail to be serviceable in dyspepsia and other diseases of the digestive organs."

Dr. Gesner found various classes of marine organisms in the limestones of Windsor, Shubenacadie and Gay's river connected with the red sandstones and shales. These he at first referred to the Lias of Great Britain in accordance with his view that the sandstones were New Red, but in a later work stated that these rocks were Carboniferous.

Dr. Gesner mentions the occurrence of salt springs at several places in the red marl or shale group in Cumberland county, and infers from this the presence of important beds of salt beneath the surface. Both he and Messrs. Jackson and Alger take the salt springs as an indication that these sandstones are "New Red" or Triassic.

The districts that Dr. Gesner included in the new Red Sandstone have been since divided by geologists into New Red or Trias and Lower Carboniferous. In later years Dr. Gesner accepted this assignment of the red marls and gypsum beds to the Carboniferous, as may be seen by consulting his later work, Industrial Resources of Nova Scotia (1849) p. 236.

While Dr. Gesner found only *four districts* in Nova Scotia, his Red Sandstone district included also the *Coal formation*, which he regarded as underlying the red sandstones and so did not distinguish on his map. His map in this respect does not differ from that of Jackson and Alger. He devotes considerable space to a description of the various coal basins in the northern part of the province; and to the Cobequid Mountains. He claims to have discovered the importance of this chain as a natural division between the various coal basins there. This chain, says he, contains primary rocks, but is in general composed of graywacke and has enormous ridges of porphyry.

The coal mines at Pictou had been opened at this time. The Albion mine was being operated by the General Mining Association, but only to a moderate extent, and coal mining elsewhere in Nova Scotia was then scarcely pursued at all. Dr. Gesner mentions that he found a few men at work on the "King Vein" at the Joggins. No work had been done at Springhill, although a good seam of coal had been found there. The locality was not at that time within the reach of profitable mining owing to its isolated situation.

We find that Dr. Gesner with many of the geologists of his day, held the opinion that the coal flora in its "tropical luxuriance indicated the presence of a very hot climate at the time when it flourished. Lofty palms, cacti, Araucarian pines, ferns and enormous rush-like plants" then covered the ground. These, on account of the perfect preservation of their most delicate parts, he conceives to have lived, died and been buried before the Noachian Deluge.

Among the fossils occurring at the Joggins Gesner enumerates the following:—*Lepidodendron aculeatum* Sternb. *Sphenopteris trifoliata* Brongt. Flag-like leaves [*Cordaites borassifolia* Sternb?] Cacti = *Variolaria* Sternb. [= *Stigmaria* of modern authors.] Conifers [= *Dadoxylon*] *Syringodendron* [probably *Sigillaria* sp.] *Palmites sulcatus* [probably a *Sigillaria*]. *Phytolithus transversus* Steinhaur, possibly a *Sternbergia*. Other plants are referred to in general terms. Gesner estimated that half of the plants he found were ferns.

In describing the *Trap district* Dr. Gesner began at the western end, at Brier Island, and as Messrs. Jackson and Alger began at the same point the two descriptions are very similar as far as Peters Point, eastward of Digby Gut, where the exploration of the last named writers ceased, so far as the Bay of Fundy is concerned. East of this at French Cross Dr. Gesner had the good fortune to discover the red sandstone cropping out from below the amygdaloid and trap at low water mark. Along this shore as far as Black Rock, Dr. Gesner found beautiful crystals of calcareous spar, heulandite, laumonite, stilbite, analcime and other zeolites. Here also he found prehnite [a rare mineral in the Nova Scotian trap].

In the vicinity of Parrsboro, where Dr. Gesner appears to have spent some time, more careful explorations were made and a variety of rocks and minerals were observed. From this convenient centre he made excursions in various directions; visiting the high cliffs of Blomidon, along whose base a variety of agates and zeolites are found; in a westerly direction he visited the broken shore by Spencer's Island and Cape d'Or, collecting native copper, etc., from the trap; he did not find at Cape Chignecto the large area of trap rocks described by Jackson and Alger; in the opposite direction he explored the north shore of Minas Basin, studded with small islands and projecting points of trap.

Our author was greatly impressed by the noble scenery along the northwestern coast of Nova Scotia, and takes great delight in describing the peculiarities of this basaltic range—the columns of the trap and the step-like successive layers; the crumbling cliffs of amygdaloid and the varied and beautiful minerals it contains. He supposes these minerals to have been introduced into the amygdaloid by the agency of heat, either by igneous fusion,* or by sublimation.† These views would hardly be accepted at the present day, especially as regards the zeolites.

The theories presented in this work by Dr. Gesner show an extensive acquaintance with the writings of the earlier geologists. We find him quoting the geological works of Buffon, Werner,

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* Pp. 180, 192 and 286. † Pp. 218, 241.

Hutton, Burnet and Conybeare and Philips as well as Buckland. He displays considerable acquaintance with the "Principles" of Lyell but of course knew nothing of Lyell's later works, consequently his reasoning in this book on Nova Scotia is all based on the opinions of the early writers

All through this work there are very sanguine opinions expressed as to the mineral wealth of Nova Scotia, especially in coal and iron. As regards the former mineral these opinions have been fully borne out by later developments, and it is probable that as time goes on the large deposits of iron ore which Nova Scotia possesses will also be more fully utilized.

TITLES, SUBJECTS, AND ITINERARY* OF DR. GESNER'S GEOLOGICAL REPORTS.

First Report on the Geological Survey of New Brunswick, by Abraham Gesner, Provincial Geologist, etc., 1839, St. John, (87 pp).

PAGE.	
1	Introduction.
12	Mountain Range along the South Coast.
15	St. Andrews,
25	St. Stephen.
27	Islands. of Passamaquoddy Bay.
29	Deer Island.
30	Campobello.
33	Grand Manan.
42	Passamaquoddy.
47	Magaguadavic.
48	L'Etang.
49	Beaver Harbor.
51	Poclogan and Leproe
54	Musquash.
58	Lancaster.
63	St. John.
66	Nerepis Road to Fredericton.
68	Magaguadavic to Oromocto.
72	Iron Ore.
74	Carboniferous Limestone.
75	Old Red Sandstone, Argillaceous slate and Granite.
77	Coal Measures.
78	Diluvial collections.
81	Concluding remarks
83	Glossary of Geological terms.

Second Report on the Geological Survey of the Province of New Brunswick, by Abraham Gesner, Provincial Geologist, St. John, 1840 (i. to xii. and 1-76 = 88 pp.)

PAGE.	
i.	Introductory.
1	General Remarks.
6	St. John
13	Black River.
15	Quaco.
23	Hopewell.
24	New Horton.
25	Grindstone Island.
26	Shepody.
29	Cape Maranguin.
33	Fossils of Chignecto Bay Coal Field.
38	Action of the Sea on the coast.
40	Exploration of the Interior.
40	Hammond River.
45	Hampton.
46	Sussex.
49	Petitcodiac.
52	Shediac.
54	East coast of Westmorland.
55	Baie Verte.
56	Sackville
59	Dorchester.
60	Westmorland Coal Field.
73	Glossary of Geological terms.

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* See Map of his journeys opposite the title-page.

Third Report on the Geological Survey of the Province of New Brunswick, by Abraham Gesner, F. G. S., Provincial Geologist, etc., St. John, 1841 (i. to xv., 1-88 = 103 pages.

PAGE.
i. Letter, v. Introduction.
1 County of St. John.
6 Mispec.
10 Black River.
12 Emerson's Creek.
13 Ten Mile Creek.
15 Porphyry.
16 Observations on the State and Graywacke of the Coast.
17 Elevated Coast, Raised Beaches, etc
21 Tertiary Formations.
22 Animal Remains.
24 Hammond R., Westmorland Coal Field.

PAGE.
28 New Red Sandstone.
31 Smith's Creek.
32 Mill Stream.
34 General view of New Red Sandstone of Westmorland and Kings Counties.
38 Mineral Contents, Lead, Rock Salt, Iron, Gypsum.
42 Valleys of Denudation.
45 Agricultural Character of New Red Sandstone District.
46 Kingston.
50 Springfield.

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51 Iron Ore.
55 Wickham.
59 Washademoak.
62 General Remarks on New Brunswick Coal field.
63 Grand Lake.
70 Salmon River.
77 Alluvium of the St. John River.
80 Portion of a Jaw-bone.
81 Record of Borings at Salmon River.
84 Glossary of Geological terms.

Fourth Report on the Geological Survey of the Province of New Brunswick, by Abraham Gesner, F.G.S., Provincial Geologist, etc., St. John, 1842 (101 pp.)

PAGE.
3 Letter.
5 Introduction.
18 Graywacke and Slate.
24 Coal Field South of the St. John River.
25 Exploration of Scoodic and Cheputneticook Rivers and Lakes.
42 Red Paint.
43 Limestone.
44 Woodstock.

PAGE.
50 Northampton, Southampton, etc.
51 Mineral Springs.
54 Terraces.
63 General Description of Great Coal Field of New Brunswick.
70 Physical Features of the Great Coal Field.
71 Peat.
72 Rocks and Minerals of the Coal Field.

PAGE.
78 Fossils of the Coal Field
80 Plants of the Coal Field
84 Topographical Details.
84 Tidnish River.
85 Cocagne.
87 Richibucto.
89 Coal.
91 Bog Iron Ore.
92 Kouchibouguac.
99 Nashwaak.

Report on the Geological Survey of New Brunswick, with a topographical account of the Public Lands (and the district explored in 1842), by Abraham Gesner, F. G. S., Provincial Geologist, etc., St. John, 1843 (88 pp).

PAGE.
3 Letter.
5 Introduction.
12 Topographical Report.
25 Tobique River.
34 Exploration of the Restigouche River.
47 Public Lands.
51 Geological Report.
55 Recent Alluviums.
56 Ancient Alluvium.
59 Tertiary Deposits.

PAGE.
61 Red Sandstone, Gypsum, etc.
63 Coal Formation.
68 Silurian System.
67 River Saint John.
69 Silurian Rocks of Bay Chaleur.
72 Cambrian System.
73 Granite, Syenite.
74 Trap, Serpentine.
75 Economic Geology.

PAGE.
76 Various Alluviums.
77 Marl, Clay, Sand.
78 Salt, Gypsum, etc.
79 Water Limestone, etc.
80 Flagstones, Grindstones, Slate, etc.
81 Coralline Marbles, Serpentine, Granite.
83 Coal, Iron, Lead.
84 Manganese, Copper
86 Lime in Agriculture.

N. B.—Of the 467 pages of texts of these reports, 85 are devoted to a description of the coal fields and their products.

GEOLOGICAL SURVEY OF NEW BRUNSWICK.

It would appear that immediately after the publication of his work on the geology and mineralogy of Nova Scotia, Dr. Gesner turned his attention to the neighboring province of New Brunswick, for in his first report on the geology of this province he stated that in 1837 he had obtained an outline of the geographical features of that part of the province which borders the Bay of Fundy; and it would seem that before he began exploration for the provincial government he had (by request of private individuals?) visited the lead mine at Lubec in Maine.

At the close of his first season's work he was able to give the following general sketch of the geological structure of the southern part of New Brunswick:

> "The southeast side of New Brunswick, or that part which reaches near the coast, extending from Shepody Bay in the county of Westmorland (now Albert) to the American boundary line in the county of Charlotte, is occupied by an extensive and moderately-elevated chain of mountains, composed principally of granite and other primary rocks. This range is situated at an average distance of fifteen miles from the shore of the Bay of Fundy, and includes the highlands eastward of the river St. John. Westwardly, it embraces Bald, Eagle, Douglas, Pleasant and other mountains. The course of this mountainous district is from southwest to northeast.
>
> "At the southern base of this elevated region the slates and limestones of the transition series, and the sandstones and conglomerates of the secondary formations, are placed in their usual order of succession, wherever they have not been broken up and buried by extensive eruptions of volcanic matter. All these rocks have been penetrated by large and numerous dykes of trap, basalt and porphyry, and the surface of the country * * * exhibits the clearest evidence of having been the theatre of violent earthquakes and intense volcanic action.
>
> "The granite entering into the structure of this mountain chain is also succeeded on its northern side by slate and graywacke * * * then follow the rocks of the great coal formation which extends from the head of the Oromocto river in a north-east direction to Northumberland Straits."

Such is the outline which Dr. Gesner gives of the geology of southern New Brunswick; and this his various journeyings during the first three years that he was engaged on the survey of New Brunswick served to complete and extend. His fourth year's work took him beyond the district covered by this outline and in his fifth year he was engaged in exploring the wild lands and thinly settled districts in the northern part of the Province.

Dr. Gesner began his exploration in Charlotte County by making an examination of the St. Croix river and the islands off the coast of that county. On the river he found two mineral springs, of one of which, at St. Stephen, he gives an analysis; on the islands he found indications of various metals, at Campobello veins of galena, in the bold trap cliffs of Grand Manan, zeolites and other minerals similar to those of the traps of the North mountains in Nova Scotia; a remarkable discovery here was that of an extensive tract of sunken ground off the south-eastern coast of the island, where the anchors of vessels become entangled in the roots of trees imbedded in the bottom of the sea near the shores.*

At Lepreau he found the coal formation with coal-measures containing various fossils, some of which were like those of the fir tribe, others were ferns, and others stigmariæ. The coal basin, however, was of very limited extent, as it was found to terminate about three miles inland. Further along the coast, at Musquash, he found verd-antique marble and alum slates.

Dr. Gesner now made traverses of the interior for the purpose of obtaining a knowledge of the strata on both sides of the granite axis of the Nerepis hills. He first passed across the granite ridge by way of the Nerepis road as far as Oromocto, and then made a traverse further west along the Magaguadavic and Oromocto rivers to the same point, intersecting the metamorphic and igneous rocks, and a part of the central Carboniferous area of the province. In these traverses he discovered some iron ore, roofing slates and a granite quarry. During these journeys he had excellent opportunities of observing the southward movements that had occurred in the loose surface deposit or "diluvial collections." These he attributes to the effects of a "general deluge that swept over the country from north to south," and to this cause also he refers the glacial striæ; "these are seen to cross each other at different angles, and this affords evidence that the course of the current was not always uniform."

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* First Rep. p. 40.

In his second year he first made a voyage along the coast eastward of St. John to the head of the Bay of Fundy. He then returned to St. John and made a parallel traverse of the country along the valleys of the Kennebecasis and Petitcodiac rivers, and examined the eastern coast of Northumberland.

In going eastward along the coast Dr. Gesner found a small coal field at Quaco, where excavations had been made upon an impure seam of coal, and at Quaco Head he examined the intrusive trap and deposit of manganese that exists there. Following the coast eastward he found some remarkable conical hills of serpentine and trap at Great Salmon river. At Hopewell he again met the coal formation and the valuable freestone and grindstone beds of that parish, and this formation was found to extend across the Petitcodiac river.

In his traverse of the interior Dr. Gesner found another coal basin, which he called the Westmorland coal field. This was found to extend from Sussex, where he examined a bed of coal, to the eastern shore of the province at Shediac. He found coal also on the Pollet River and Turtle Creek, and further east. These last were probably cannel coal, or highly bituminous slate. The ash varied from twelve to twenty-five per cent.*

In his third year he re-examined a part of the coast east of St. John, and then the "new red sandstone" district in Kings county. Afterward he made excursions on various branches of the St. John river, among the rest Belleisle Bay, and Washademoak and Grand Lakes.

In the report on this year's explorations Dr. Gesner summed up the result of his three years work in this difficult region, whose complicated geology has exercised the minds of many investigators since then. His work was so far advanced that he now prepared a geological map of this southern part of the province, the first that had been made. This map, which has never been published, is now in the hands of the Natural History Society of New Brunswick, and is complete for the work of these three seasons.[*]

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* Second Report, p. 66.

In the first report, Dr. Gesner had announced the occurrence of Carboniferous limestone and Old Red sandstone among the "secondary" rocks north of the granites, and now in this third report gives a somewhat extended account of raised beaches and estuarine deposits. These raised beaches with their shells he refers to the *Newer Pliocene* of Sir Chas. Lyell.

Following this is an account of the Westmorland coal field and of the New Red sandstone of Westmorland and Kings counties; the minerals of the latter formation are said to be lead, iron, gypsum and rock salt. It is probable that if Dr. Gesner had worked long enough in this "New Red sandstone" tract, he would have referred it to the Carboniferous System, as he subsequently did that of Nova Scotia, similarly characterized by gypsum and salt springs. Dr. Gesner observed several valleys of denudation in this district. The report closes with an account of the Grand Lake coal field and of the alluvium of the St. John river.

In this report it will be observed that Dr. Gesner had made an advance in his knowledge of the "transition" rocks in the southern part of the province, for while he had previously spoken of the Graywacke as one system, he now finds that there are two. One he calls the upper, or newer, having found it to rest unconformably on the other, and to be characterized by the remains of marine shells and land plants. The older Graywacke did not contain organic remains. A figure is given of one of the molluscous animals of the newer Graywacke (which he compares to the *Silurian* of Mr. Murchison) and as Dr. Gesner mentions the locality from which it came we know it to have been obtained from the shales of Division 1, Band *c*, of the St. John Group. In the fauna of this band, the only fossil that will answer to Dr. Gesner's "terebratulite" is *Orthis Billingsi*, Hartt. Examples of this fossil, in which the ears are broken off or concealed in the matrix, would resemble the terebratulite.* Dr. Gesner also found this formation to contain plant remains in the form of a "cactus" (or Stigmaria).

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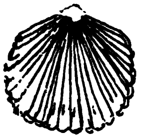
[*] An amended copy is on file in the Crown Lands Office at Fredericton. See description of the orginal map on a later page.

[†] They are now regarded as Post-Pliocene.

Fig. 1.



A Terebratulite Slate of St. John.

In an upper set of beds other plant-remains were found. These were discovered at Little River and consisted of trunks of trees, *conifera*, a calamite, impressions of leaves, and a plant called a *Phytolithus*†, which probably was a Sigillaria. From the description of the locality it is evident that these plants came from the Dadoxylon sandstone, of the Little River group. Dr. Gesner was thus the pioneer in making known the fauna of the Cambrian and the flora of the overlying pre-carboniferous rocks in New Brunswick. That he did not reach the full significence of his discoveries is not at all surprising, for the district where these two classes of remains are found is a very complicated one; and the study of its geology for half a century past has hardly yet resulted in the unravelling of its complicated structure.

Dr. Gesner's older Graywacke group is exemplified in the Huronian schists of the Coastal group and the altered schistose rocks between Cape Mispec and Emerson's Creek along the shore of the Bay of Fundy.

In his fourth report we find that Dr. Gesner revised his reference of the Graywacke system, and upon the ground of the scarcity of organic remains, a few *terebratula* and some land plants only having been found, he classes it with the Cambrian system of Professor Sedgewick. This classification he carried out in a more systematic way, as regards the northwestern part of New Brunswick the next year, when he made his final report.‡

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* Second Report, p. 8. † Second Report, p. 12. ‡ Fifth Report, p. 54.

During the fourth year of his survey, Dr. Gesner was engaged in extending the work of previous years to the United States boundary and Woodstock, on the one hand and to the mouth of the Miramichi on the other. He traced a belt of "primary" rocks (granite, etc.) from the Cheputnecticook Lakes to the sources of the Miramichi, marked the boundaries of a large forked area of Cambrian rocks, and located the western and northern bounds of the large central carboniferous area of New Brunswick.

At this time, apparently, Dr. Gesner became acquainted with the Glacial theory, and refers to the inquiries of Agassiz, Buckland, Lyell and others into facts connected with the glaciers of Switzerland, Scotland and Ireland,* and he thinks it probable that many parallel ridges of sand and gravel in New Brunswick have been produced by the operations of ice; but we do not find that he used this theory subsequently in accounting for grooved surfaces on the rocks, which he still attributes to diluvial floods from the north. "The Glacial Period," says Gesner, "introduces the opinion that between the period of the enormous animals, the bones of which are buried in diluvial districts, and the present epoch, there was a period of intense cold."†

The fifth report (entitled "Report on the Geological Survey of New Brunswick with a topographical account of the Public Lands and the district explored in 1842) describes the country of the Upper St. John and the wilderness and forest country on the headquarters of the Tobique and Restigouche rivers. In this area Dr. Gesner found an extensive area of Silurian slates and overlying tracts of red sandstones with limestone and gypsum deposits.

Through the information on the geology and natural products of the province which these reports contained, a great deal of interest in her mineral wealth was excited, and the popular mind was filled with large expectations of the development of her mines. A number of mining adventures were undertaken, some of which were successful, but many the reverse. In Albert county, especially, large amounts were invested in the Albertite mine (discovered soon after Gesner completed his surveys) and in the sandstone quarries on the coast and the Petitcodiac river. The mining of coal in Queens county was prosecuted with vigor, and iron furnaces were started at Woodstock. But the returns from these sources did not prove so valuable as from the mines of the neighboring province, and discredit was thrown on the work of Dr. Gesner. He had committed the error of expressing an opinion on the mineral wealth of the province more favorable than the after results justified, and hence a reaction came which probably helped to terminate his engagement with the provincial government. This, however, hardly justified the withholding of his salary for the last year, which was not paid for some time after the work of exploration terminated.*

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* Fourth Report, p. 59. † Fourth Report, p. 12

In judging of Dr. Gesner's work, I think sufficient allowance has not been made for the imperfections of the science of geology in his time. He lived, or at least his training was obtained in the formative period of the science, almost before its general principles and laws were formulated. From his earlier works it will be noticed that he interpreted geological phenomena by the theories of Werner and Hutton; in later years he decides the age of the several terranes which he found in the metamorphic hills of southern New Brunswick on the tests and data of Sir Roderick Murchison and Professor Sedgewick, and finally he became acquainted with the theories of Agassiz and Lyell, relative to the glacial period. We are not to expect from a geologist living in that early period, the exact methods of the modern trained specialist.

The limestone beds in the Narrows of the St. John river to which Gesner drew attention, have been largely quarried for lime of late years, and that a similar result has not flowed from the discovery of deposits of iron ore and gypsum described in his reports, is in part due to the modern conditions of trade, and especially to facilities for transportation in recent years which shuts out from commercial competition all but the purest and most extensive mineral deposits.

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* The following is an extract from a letter from Dr. Gesner to Hon. G. S. Hill, St. Stephen, dated Cornwallis, N. S., 7th August, 1844: "I need scarcely add that so far I am unable to obtain a whole year's salary due from the province for services ordered and duly authorized by Sir William [Colebrooke, the Lieut. Governor] * * * and I can hardly express my dissatisfaction and mortification."

PALÆONTOLOGY OF DR. GESNER'S REPORTS.

Dr. Gesner appears not to have been deeply versed in the science of Palæontology, which in his day was going through the formative process. Its foundation principles were generally known, but the means of its special application were not always at hand. Authentic specimens of typical forms were not easily accessible on this side of the Atlantic, and the photographic camera and other appliances of which the modern artist can avail himself, were not within reach of the engraver half a century ago.

From these and other causes the palæontological references and figures in Dr. Gesner's reports are crude and often difficult to comprehend. Any errors into which the writer may have fallen in the interpretation of this part of Gesner's work, may perhaps, on this account, be excused.

The following outline references will enable the reader to determine how far it will be necessary for him to study the original reports. The marginal references are to the number of the report quoted, and the page.

I. 20. Johnston's and Simpson's Cove, Charlotte Co. Marl with clam, mussel and scollop shells. [Post-pliocene, Champlain.]

1. 40. Grand Harbor, Grand Manan. Sunken forest in the harbor. Pine, hemlock, cedar. [Recent.]

I. 52. Lepreau, St. John Co. Fossils of Fir tribe, ferns, stigmaria. [Little River Group.][*]

I. 70. Hartt's Mills, Oromocto. Conifera, Calamites in Carboniferous conglomerate. [Millstone Grit.]

I. 74. Otnabog L., Queens Co., one mile south of. Limestone with ammonite [Nautilus] encrinite, trilobite, ostrea [some other genus], Mya [Edmonia?], arca [Macrodon?], are common. [Lower Carboniferous.]

II. 7. "The Valley," [City of St. John], Mya, Pecten, Mytilus, and other shells in clay, eighteen feet above level of the sea. [Post-pliocene.]

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[*] The plants from this terrain have been determined by Sir Wm. Dawson.

II. 8. Valley, north side of, opposite Jeffrey's Hill [Garden street.] Slate with remains of shells, Terebratulite. [Supposed to be *Protorthis Billingsi*, Hartt, of the Paradoxides Beds on Seely street. [Cambrian.]

II. 12. North side of Little River, near the bridge, in compact Grauwacke. Trunks of two large fossil trees, belonging to the Conifera. [Trees similar to these have been determined by Sir J. W. Dawson as *Dadoxylon Ouangondianum.*] Other smaller plants and impressions of leaves, species of Phytolithus* and a calamite [*Archæocalamites* (=*Bornia*) *radiatus.*] Little River Group.

II. 12. City of St. John, near the residence of "His Worship," [*i. e.*, the Mayor, on the south side of King Square.] Remains of a cactus. [Probably a worm-pitted flagstone. Cambrian.]

II. 15. Quaco Head, St. John Co. In grey sandstone. Two species [*i. e.*, varieties] of cactus, [*i. e.* *Stigmaria ficoides*] and a calamite. [Carboniferous.]

II. 25. Grindstone Island [Albert Co.] In sandstone. Fossil trees two feet across and forty feet long exposed on the side of a cliff. It is branched and belongs to the Dicotyledonous order. [Carboniferous.]

II. 34. Chignecto Bay. Coal formation. *Conifera*, *Syringodendron*, [*i. e.*, decorticated Sigillariæ] four species. At Cape Marenguin, *Phytolithus*, one species. Calamites are numerous—4½ inches across. [Carboniferous.]

II. 35. Same district. *Sigillaria*, two species. [The figures seem to represent *S. tessellata*, Brongn.] *Cactæ* [*i. e.*, Stigmariæ.] Ferns [*Alethopteris lonchitica*?] and other plants. [Carboniferous.]

II. 59. Tantramar Marsh, Westmorland Co. Large trees of different kinds, collections of shells and bones of fishes found buried at different depths in the marsh. [Recent.]

II. 63. Sussex, Kings Co. In sandstone and shale. Large cacti [*i. e.*, Stigmariæ] and calamites, and leaves of other plants. [Carboniferous].

III. 5. Kennebecasis to Cape Mispec [near St. John], In clay slate frequently ferrugenous, Marine animals and land plants [?] alternately [Cambrian]. At Little River, in arenaceous beds, Fossil trees [Little River Group].

III. 7. St. John, near Jeffrey's hill, remains of marine animals, and land plants [?] [Cambrian].

III. 14. Ten Mile Creek, St. John Co. Sandstone and shale. Calamites, common, also fossil trees [Carboniferous].

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* Phytolithus was a generic term used very indefinitely by Steinbaur, it might mean any fossil stem not a calamite or a stigmaria. See notes on Gesner's Geological map, p. 31.

III.	17.	Various localities in St. John County. In marl and marly clay; over thirty specimens of testacea and crustacea, *Mya mercenaria* [*i. e. arenaria*], *Pecten* [*islandicus*] *mactra*, *Solon ensis* [doubtful if these two occur] *mytilus*, two species, [probably *M. edulis* and var. *elegans*.] Claws of crab, bones of fishes [*Post-pliocine*].
III,	30.	Buttternut Ridge, Kings Co. In limestone encrinites ammonites [Nautili] and several species of bivalve shells [Brachiopods]. [Lower Carboniferous.]
III.	56.	St. John River, east side of head of the Reach, farms of Messrs. Carpenter, Queen's Co. In Carboniferous limestone, ammonites [*i. e.* Nautilus], encrinites, astrea [?], orthis [extinct in Carboniferous time, probably Productus] pectenite [perhaps Aviculopecten] several species of terebratula [*T. sacculus* and varieties].
III.	60.	Long Rapid of Washdemoak River, Queen's Co. In sandstone, etc. Large trees, cacti [*i. e.*, Stigmariæ], calamites, etc.
III.	64.	Grand Lake coal field. Point between Young's Cove and Cumberland Bay. Reddish calcareo-argillaceous deposit with remains of marine plants like *laminaria saccharina*.
III.	68. 69.	Grand Lake, Long Point, south side of. Fossil trees [Conifera], a *phytolithus* and a *calamite*.
III.	74.	Grand Lake, Salmon River mines. *Cacti* [*i. e.*, Stigmariæ], scarce; ferns more numerous.
IV.	19.	Graywacke and State. Same fossils as are referred to in Report II, pages 8–12.
IV.	80.	Richibucto, *sigillaria* 2 ft. 4 in. in diameter. Bathurst, Gloucester Co. Two species ferns different from any figured European species.
IV.	95.	Chatham, Northumberland Co. In sandstone. Ferns and coniferous plants, no cactacea [*i. e.*, Sigillariæ] observed.
V.	60.	Jacquet River, north of, Nash's Creek. In clay beds. *Mya mercenaria* [= *arenaria*], valves of *Balani* [*B. crenatus* and *B. Hameri* occur here], two species of *Mytili* [*M. edulis* and var. *elegans*] *pecten concentrica* [probably *Cyprina Islandica*].
V.	64.	Point La Nim. Soft shales. Restigouche Co. *Stigmaria* [perhaps *Psilophyton.*]
V.	64.	Escuminac Bay, east of, Restigouche Co. In sandstone and shale. Remains of a small fish [perhaps *Phaneropleuron*] and a small species of tortoise [fish, *Pterichthys Canadensis*], also fossil foot marks.
V.	67.	Presqueisle River, Flannagan's Hill, Victoria Co.? In impure limestone *Cyathophyllum basaltiforme* [?] columns of encrinites, casts of producta. Elsewhere called *producta depressa*, [*i.e. Leptæna rhomboidalis*] of the Wenlock Limestone.

V. 70. Belledune Point, Gloucester Co. Impure limestone containing spirifera [*S. cycloptera?*] producta [*i. e. Leptæna rhomboidalis*]. Encrinites, *Favosites Gothlandica. Cyathophyllum turbinatum* [?] a coral like *Syringopora geniculata.*

V. 70. River Charlo, south side of Restigouche Co. In limestone, a shell like *Atrypa reticularis.*

V. 71. Bathurst. J. W. Henwood found *Favosites Gothlandica, Producta depressa* [= *Leptæna rhomboidalis*] *Atrypa aspera,* crinoidea, *Leptæna* [*Strophonema*] *euglypha* and *Spirifera* [*S. cyclopetera*]. Besides these, I [A. Gesner] observed several shells, whose species have not been determined.

GESNER'S GEOLOGICAL MAP OF NEW BRUNSWICK.

The absence of a geological map is greatly felt by the reader who attempts to obtain a knowledge of early geological exploration in New Brunswick from the reports of Dr. Abraham Gesner. From time to time in the text of these reports references to a map in course of preparation are met with ; but no complete map of his exploratory work is extant, and the one he made to show the result of his first three years' work has never been published. This map for many years has been in the possession of the Mechanic's Institute at St. John, and has lately been acquired by the Natural History Society of New Brunswick. A copy of the map was lodged with the Crown Lands Department at Fredericton.* Dr. L. W. Bailey, of the University of New Brunswick at that place, has never seen any other map by Dr. Gesner, and does not know of any there. The original map in the possession of the Natural History Society, therefore, seems to be the one to which we must look to primarily for a representation of Dr. Gesner's work in New Brunswick.†

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* See Report on the Agricultural Capabilities of New Brunswick, by J. F. W. Johnston, F. R. S., Fredericton, 1850, p. 6.

† The first reference to this map will be found in the Second Report, page xii, where Dr. Gesner says, "The geological map of the province has been commenced and is advancing towards completion." Again, in the Third Report, page iii, he says that the report "is accompanied by a geological map of that part of New Brunswick which has been examined." In the Fourth Report, page 4, he states that "a geological map will be with this report laid before your Excellency, the labor of past season being added to that which was before completed." Also at page 18, "Each of the different classes of rocks has been laid down on the geological map of the province, now in course of preparation." In the Fifth Report he adds, "an incomplete geological map of the province is submitted for your Excellency's consideration." I have not been able to discover that this "incomplete map" is any other than the one described in the previous report.

To Mr. Geoffrey Stead, C. E., the author is indebted for the copy of Gesner's map in black-line hatching which accompanies this paper. (See page 39).

It has been thought that Dr. Jas. Robb's geological map of New Brunswick embodies that of Dr. Gesner, but on a comparison of the two I find that this is not the case. It seems, therefore desirable that this first geological map of the province should be published so that those who wish to read Dr. Gesner's reports may do so with a map before them.

The publication of the map is also desirable, as no opportunity has heretofore been given to compare it with the geological map of New Brunswick published some years later by Dr. Jas. Robb.* It also affords the means of comparison with the geological map of New Brunswick, etc., published by the Dominion Geological Survey.

Dr. Gesner's original map represents only the first three years of his explorations, but from the one filed with the Crown Lands Department at Fredericton, a copy of which I received through the kindness of Mr. Loggie, I have added the results of his fourth year of exploration. This extends the map as far as Woodstock on the western side of the province, and to Shippegan on the eastern.

There is no index to the several geological formations on the original map, but the colors used by Gesner are easily understood from his reports, and from the index on the copy of the map in the Crown Lands Office.

Eight divisions are indicated by the colors on the original map, and are as follows :

Lias Limestone.
New Red Sandstone.
Coal Formation.
Mountain Limestone.
Old Red Sandstone.
Graywacke System.
Syenite, Trap, etc.
Granite.

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* Published with Johnston's Report on the Agricultural Capabilities of New Brunswick. But many copies of this report were issued without any geological map. At page 6, Dr. Robb tells us that his map was to a great extent based on the reports of Dr. Gesner.

The Intrusive Rocks.

Dr. Gesner at an early date recognized the granitic range of the Nerepis hills as the key to the geological structure of southern New Brunswick. He noticed also that the sedimentary beds resting on the flanks of the granite hills were more or less broken up, and to some extent buried by extensive eruptions of volcanic matter, and had been penetrated by numerous trap dykes. This was the generalization he made at the end of his first year's work. But in the second year of his survey, he found that the true granite terminated at Belleisle Bay on the river St. John; and he also discovered (or thought he did) that the ridge of the crystalline rocks curved southward from there, and as a belt of syenite, etc., extended westward along the south side of the granite range, and eastward through Kingston, the Loch Lomond hills and along the Shepody road to Shepody mountain in Westmorland County.

In the fourth year of his survey he traced another granitic axis, extending from the Cheputnecticook Lakes, northeastward toward Bathurst on the Gulf of St. Lawrence. The western end of this axis is shown on the map, but the eastern lies beyond its limit.

In comparing this old map of Dr. Gesner's with that of Dr. Robb, who was his successor in the study of the geology of New Brunswick, one may observe that in some respects the former is more accurate than the latter, as, for instance, in the boundary of the granitic area of the Nerepis hills; and theoretically more correct in other respects, as, for instance, in the distribution of the syenite and trap rocks, which by Dr. Robb are represented as round isolated masses in many cases, but by Dr. Gesner as occupying elongated areas. Among the metamorphic tracts these intrusive rocks have usually come out through long fissures parallel to the general trend of the several bands of sedimentary rock. Only within the Carboniferous area, and at Grand Manan, are there broad sheets of eruptives undisturbed.

Later studies on the "trap rocks" of southern New Brunswick show that in many cases the rocks represented as intrusive are really old lavas and ash-rocks, both of Post-Cambrian and Pre-Cambrian systems, originally spread out in broad sheets, but which, now, owing to the folding of the strata with which they are interbedded, exhibit their worn edges at the surface, and thus have the elongated out-crops which Dr. Gesner represented on his map.

Gesner's "New Brunswick"* gives the latest view which that author has expressed on the extent and arrangement of the intrusive rocks in that province. The *granite* in this work is described in much the same terms as in his reports above cited.

But in this work he divides the syenite ridge of his Second Report† into two parts; one of syenite extending from the Kennebecasis through St. John County to Albert County‡ corresponding in its western part to the syenite of the Laurention axis of the Dominion Survey Reports, and in its eastern part to the syenites, etc., of the Huronian (Coldbrook) rocks of St. John County.

The other division of the syenite ridge is its western part and is called "trap." The places mentioned as being on the§ course of this band, except Red Rock Lake, || show that its western part is composed of the bedded traps which cap the (Upper) Silurian system in Charlotte County; its eastern part consists of the bedded traps of the Kingston series.

Dr. Gesner was thus by degrees learning to distinguish the differences which exist between the effusive rocks and the intrusive rocks forming the core or axis of the metamorphic range traced by him in southern New Brunswick. His divisions may be interpreted as follows:

Granite.—The Devonian granite of the Nerepis range.

Syenite.—The intrusive Syenites of the Laurentian and eastern Huronian (Coldbrook) areas.

Trap.—The old lava flows and intrusive dykes of the Silurian (Upper) and the Kingston series (Huronian).

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* New Brunswick, with Notes for Emigrants, by Abraham Gesner, F. G. S., etc. London, 1847.

† Second Report, p. 2. ‡ "New Brunswick" p, 342 § Op. cit, p. 343.

Red Rock Lake is among the intrusive granites.

The Graywacke System.

In classifying the rocks in the southern part of New Brunswick, Dr. Gesner at first divided them into the three simple classes recognized by the earlier geologists, viz.: The Granite and other crystalline rocks; the Transition series; and the Secondary formations. Thus the transition rocks are the more or less altered rocks of the metamorphic *massif* or complex of southern New Brunswick; and include all the terranes from the Laurentian to the Devonian. Dr. Gesner, however, proceeded to improve his classification year by year as his survey progressed. In the second year of his survey he made some important discoveries of fossils near St. John which led him to conclude that the slates and graywacke of the transition rocks crossing the harbor of St. John, and at the entrance of the river of that name, were to be classed with the "Silurian group of Mr. Murchison."* This remark certainly applies to the slates and graywacke, and appears also to include the limestones north of them, for he asserts that the fossil shells found in the slates were afterwards met with in the limestones.† His opinion of the age of the plant-bearing beds is very clearly expressed (page 12) where he says "these plants belong to the first classes of vegetables that ever flourished on the earth. They * * are evidently far more ancient than those which afford bituminous coal."

Still extending his observations on the rocks along the coast, Dr. Gesner, in the third year of his work, found reason for a further division of the strata of the transition complex. In examining the rocks from Cape Mispec eastward he found an older and more altered set of beds, which, in relation to the Silurian rocks above mentioned, were *primary*,‡ and further he found that this older set had a reversed dip§ as contrasted with the "Silurian." In these apparently older and lower strata, no organic remains were found, and further they were harder, were more replete with quartz veins, and talc and chlorite were associated with them. Dr. Gesner therefore concluded that though the whole of these rocks belonged to the Graywacke group, the upper only bore a close resemblance to the Silurian rocks of Europe.

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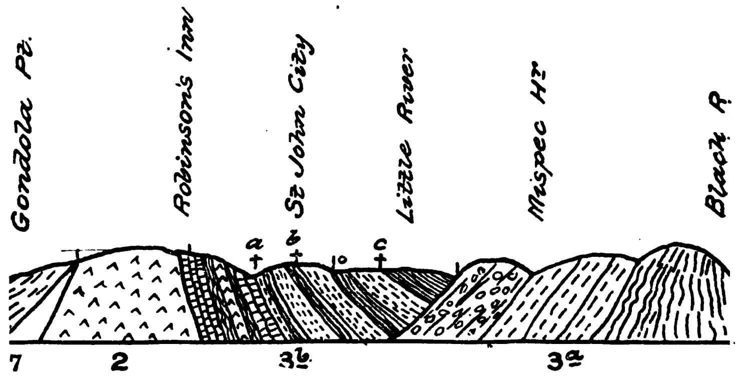
* Second Report, p. 8.

† Second Report, p. 8. This observation, however, is open to question, as these limestones are older than any rocks in which mollusca or molluscoida have been found.

‡ Third Report, p. 8. § Third Report, p. 7.

For the purpose of making plainer Dr. Gesner's brief statements of the age of the two series of the Graywacke system, and to show its relation to the intrusive and the secondary rocks, the author has constructed the following section.



Explanation of Section.—2, Intrusive Syenite. etc., (of Pre-Cambrian age.) 3*a*. Older Graywacke System. 3*b*, Newer Graywacke. 7, Red Conglomerate and Sandstone. *a*, Fossil "terebratula." *b*, "Cactus." *o*, Anthracite coal seam. *c*, Fossil coniferous trees.

This section will convey Dr. Gesner's conception of the structure of the peninsula between the Kennebecasis river and the Bay of Fundy. On the south-east, at the base of his "older Graywacke group" is a mass of hard contorted slates, and schists with beds of volcanic ash rock; the middle of the group consists of Graywacke with some clay slate, and the upper part is a mass of coarse conglomerate.

Resting on these unconformably is his "newer Graywacke group;" having at the base limestones with beds of Graywacke and intrusive trap; then the series of slates and Graywacke on which the city of Saint John is built; and finally compact Graywacke with fine grained clay slates. Dr. Gesner compared the newer Graywacke group to the Silurian of Murchison, but he does not appear to have given any name to the lower group, or to have compared it with any European system.*

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* They are called *Metamorphic rocks* in his "New Brunswick," 1847.

A casual reading of Dr. Gesner's reports would leave the impression that he continued to class his Upper Graywacke group with the Silurian; but no such classification is shown on his map, and if we examine his Fourth Report it will appear that this was not his final conclusion. There, in speaking of the Graywacke and slates of St. Stephen, which are colored as being of the same terrane as those of St. John, he calls them *Cambrian* system of Professor Sedgewick,[*] and if his language be carefully examined I think it will be plain that he intended this remark to apply also to the Graywacke of St. John. By placing together the paragraphs from the different reports, the basis for this inference will be seen.

2nd Report.	3rd Report.	4th Report.	Last Report.
P. 3, l. 12—Since we have discovered the remains of *molluscous animals*, *fossil trees*, and *anthracite* among these slates, * * * they may be classed with the *Silurian* group of Mr. Murchison. *P. 8, l. 21.*—A few strata of slate meet the chert and in them we found the remains of shells. They are all *terebratula*.	*P. 5, l. 30.* — Clay slates * * containing *marine animals* and *land plants* alternately, appear. *P. 7, l. 28.*—In the upper series * * the remains both of *marine animals* and *land plants* were found, * * * and it appears that the *Silurian* group of Mr. Murchison is clearly developed in New Brunswick.	*P. 19, l. 7.*—The only fossils found * * consist of a few impressions of *terebratula* and *plants* analagous to those of the *coal period*. * * I am inclined to believe that they may be properly classed with the *Cambrian* system of Professor Sedgwick.	*P. 72, l. 13.*— *Cambrian System*. The few organic remains found in this group are sufficiently characteristic * * * * The strata consist of grauwacke, grauwacke slate and clay slate.

Dr. Gesner carefully gave the localities for the fossil shells and plants referred to in the second and third reports, but in his fourth report he does not mention any locality for shells or plant remains near St. Stephen[†]; hence it may be inferred that the remarks quoted are of general application and based on the discoveries at St. John.

From these extracts, especially when taken in connection with the context, in the several reports, it appears to me plain that in his later reports, Gesner intended to refer to the Cambrian, the strata which in the second and third reports he had compared with the Silurian. This classification was adopted by Dr. Robb for the districts described in the fourth and last report, *but not for those of previous reports*, which on his map are colored as Upper Silurian.

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[*] Fourth Report, p. 19.

[†] There are really several.

We thus find that while Dr. Gesner had first spoken of the Graywacke or transition rocks as one system, he soon discovered that there were two series † included in it, and that of these two series the upper one was characterized by the remains of marine shells and of land plants, and that the older series had no organic remains. Subsequently when he came to explore the Graywacke system in other parts of the province and could find no organic remains in it he came to the conclusion that the whole should be called Cambrian on account of the *scarcity of organic remains*. So far as the geological reports are concerned, he made this his final statement of the age of these rocks, they being in this way contrasted with the Silurian (Upper) of the northern port of the province in which he met with evidences of a more abundant marine life.

The description of the locality near St. John where the marine animals of the Cambrian system were found by Dr. Gesner is as follows: "On the north side of the ravine, not far from the pottery, and directly opposite Jeffrey's Hill (Garden street) there is a bed of chert extending some distance in an east and west direction, a few strata of slate meet the chert and in them we found remains of shells."

The pottery above mentioned was situated in the valley at the foot of Garden street, and the ravine opposite would be the hollow extending up from the west end of Wright street to the west end of Seely street. Here we find the quartzite or hard sandstone of Band *a* in Division 1 of the St. John group, and immediately in front of it the Paradoxides shale (Band *c*, of the same division). There is no chert in this neighborhood, and the rock so called by Dr. Gesner, I suppose to be the quartzite of the St. John group, Division 1, Band *a*. The "few strata" of slate in this case would be the shales of Band *c*. At this point they yielded to Dr. Gesner's hammer the remains of "molluscous animals." A figure of one of these is given and is called by him a "*terebratulite*."*

We find greater difficulty in dealing with the "cactus" found by Dr. Gesner in the City of St. John, near the residence of the mayor [Robert F. Hazen, at the corner of King Square and Charlotte street.] Being found here it must have come from the flags of Division 2 of the St. John group. The strata of this locality are of such an age as to give to the cactus or *Stigmaria* an antiquity far greater than any fossil of this genus known up the present day. I therefore conclude that this object was some imitative form, and not a true Stigmaria. In the beds of Division 2 there are numerous burrows of Arenicolites; such burrows occurring in crumpled slates or flags would readily take on the appearance of Stigmaria. Many of the markings in Cambrian sandstones have been mistaken for plant remains, notably the varieties of Eophyton in the Swedish Cambrian rocks described by O. Torrell, and his *Cordaites Nilsoni;* even so cautious an observer as Linnarsson took Eophyton to be a plant.

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* Second Report, p. 8. See page 17, *super*.

But while we should be loath to admit of the presence of land plants in the St. John group without the strongest proof, there can be no doubt that Dr. Gesner did discover remains of plants at Little River near St. John, in beds now known to be much newer than the flags of King Square.* These plant remains were found in compact Graywacke, and consisted of "large fossil trees, *Conifera*, with other smaller plants and impressions of leaves." This locality, which is well known, is in the Dadoxylon sandstone of the Little River group and the trees are similar to others from this sandstone which Sir Wm. Dawson has described as *Dadoxylon ouangondianium.* Of the smaller plants mentioned, one is said to be a calamite, this probably would be *Archœocalamites radiatus (=Bornia radiata)* which occurs commonly with this Dadoxylon. Another of the smaller plants is called a *Phytolithus*. Phytolithus was a genus very loosely used by Steinhaur, having been applied by him to species of Lepidodendron, Stigmaria, Sigillaria and Ulodendron.† Gesner appears to have had access to Steinhaur's article, and I think he intended under Phytolithus to indicate here a species of Sigillaria. Badly preserved stems of species of this genus are quite common in the Dadoxylon Sandstone in some places, and Sir Wm. Dawson has described one from the extension of these beds on the opposite side of the harbor, under the name of *S. palpebra.*

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* Second Report p. 12. † Coal Flora of Pennsylvania, Lesquereux. 1880.

In connection with the plant remains (but not in the same beds) Dr. Gesner speaks of having discovered two small veins of *anthracite coal* in soft, fine grained clay slate. These slates were divided into layers of from half an inch to four inches in thickness, and were found at a small creek near the new Penitentiary. He speaks of the slate rock appearing in cliffs on the shore where the strata readily decompose. From these indications I conclude that this "anthracite" came from the fine black shales of the St. John group, which are well exposed in a low cliff on Courtenay Bay, in front of the County Alms House; the brook which discharges here comes past the Penetentiary. Much of the slate is black and highly carbonaceous, and layers of it might resemble anthracite; but the existence of true anthracite here is improbable, as the deposit is of marine origin and of Cambrian age; and its natural connection is not with the Devonian sandstone containing plant remains, but with the beds in which Dr. Gesner found the "terebratulite."

This author found the fine slates to be devoid of quartz veins, and for this reason, as well as because they contained anthracite, he associated them with the plant-bearing Graywacke sandstone, rather than with the slates and Graywacke of the St. John group, to which they properly belong, and which he found had numerous quartz veins. Dr. Gesner laid much stress on the presence of quartz veins as showing the antiquity of strata, and considered the great abundance of quartz veins in the older Graywacke group as a proof of its great antiquity.

Dr. Gesner was thus the pioneer in the discovery of Cambrian and other pre-Carboniferous fossils in the terranes at St. John; that he did not reach the full significance of his discoveries is not surprising, when we consider how little was known in those early days outside of the great centres of geological investigation, of the distinctness of the several faunas and floras included in the transition rocks.

Dr. Gesner's *older* Graywacke group also contained strata of various ages. To him, the distinctive features of this group, were its incipient metamorphism as shown by the innumerable quartz veins mixed with talc and chlorite, that traverse the rocks, and the absence of organic remains. Of the three masses of strata associated by Dr. Gesner in this lower Graywacke group, the lowest consists of the schists of the Coastal (Huronian) group, the middle of the southern basin of Dadoxylon sandstones of the Little River group and the upper part of the conglomerate beds to the north of them. The unusual hardening of the Palæozoic and older rocks at Mispec give to this "older Graywacke" group of Dr. Gesner an appearance of greater antiquity than that possessed by the strata further north.

Four years after closing his engagement with the government of New Brunswick, Dr. Gesner published a general work on that province, describing its topography, resources, etc., and giving an outline of its geology. In this there is a later expression of Dr. Gesner's views respecting the age of the schistose rocks of the southern coast. Here he classes the Lower Graywacke group with gneiss and the clastic schists under the head of *Metamorphic Rocks** and states that these rocks skirt the shores of the Bay of Fundy from Salisbury Cove to Chamcook Bay. He says that no fossils have been discovered in these rocks, and evidently they are his Lower Graywacke group.

As regards the Upper Graywacke group, it would appear that Dr. Gesner at this time was disposed to assign a part of them to a higher horizon than he had previously. In one of his geological reports he had remarked that several of these vegetable relics were discovered in slate and Graywacke, which agree in their general characters with the sandstones and shales of the upper coal series.† The thought here foreshadowed seems to have governed Dr. Gesner in his final remarks upon the plant-bearing and shell-bearing beds at St. John, for he says that the sandstones containing the fossilized remains of coniferous trees and those having a variety of terebratula, evidently belong to the imperfect coal measures, of which there are several instances in the province."*

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* New Brunswick, p. 343. † Second Report, p. 12.

One basin of such imperfect coal-measures is that of Lepreau described by Dr. Gesner;† another is that of Quaco.‡ Dr. Gesner believed that both of these basins were of Carboniferous age.

If my interpretation of Dr. Gesner's views of the age of the Upper Graywacke group is correct, he expressed successively the following opinions of the age of these rocks:

In the First Report—Transition.
In the Second and Third Reports—Silurian.
In the Fourth and Fifth Reports—Cambrian.
In the "New Brunswick,"—Part of them are called imperfect coal measures.

One more phase of opinion is that expressed in Dr. Jas. Robb's geological map of New Brunswick, where these rocks are colored as Upper Silurian. In all this time, from 1838 to 1860, no actual progress had been made in determining the true age of these strata. The first important step in this direction was taken when Sir Wm. Dawson, by the study of the plant remains, showed that the upper part of the group was at least as old as the Devonian; and the second, when Prof. C. F. Hartt found, by comparison of the mollusca with those of the Primordeal Zone, of Barrande, in Bohemia, that the lower part was Cambrian.

The unravelling of this complex Pre-carboniferous *massif* of southern New Brunswick has not only shown that it contains the plant-bearing terrane and the Primordeal terrane above mentioned, but three others in addition, besides the "fundamental gneiss," so that there is ample room for deposits of all the eras to which Gesner and Robb referred it.

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[*] New Brunswick, p. 343. [†] First Report, p. 52. [‡] Second Report, p. 15.

Old Red Sandstone.

On this map the narrow strip of measures which Dr. Gesner has called old red sandstone will not easily catch the eye. The "mountain limestone," which immediately overlies it, was no doubt the occasion for referring this belt of measures to the Old Red Sandstone. To Dr. Gesner, if we may judge by the glossary of geological terms attached to his reports, the Old Red Sandstone was a "stratified rock belonging to the Carboniferous group." This glossary is extracted from one in Lyell's Principles of Geology, a book which Dr. Gesner seems to have used a great deal, and in which the term Old Red Sandstone is similarly defined.* It would appear that, at this time at least, the term Old Red Sandstone did not convey to Dr. Gesner's mind the idea of a system different from the Carboniferous, but rather that of a Lower or Sub-carboniferous Sandstone. However, some years later (in 1847) he refers to the Old Red Sandstone as Devonian.

The Coal Formation.

The compiler of this map rightly considered this system of rocks as one of the most important in the province; and he had less difficulty in recognizing it than in telling the age of the others. Abundant plant-remains furnished the test necessary for the determination of these rocks. Though Dr. Gesner's palæobotany belongs to the earliest years of geological science, and some of his names are now obsolete, we are able from his descriptions, and sometimes from his figures, to recognize most of the plants he mentions. They are the commoner species of the Carboniferous age, but sufficient to determine the kind of flora which flourished in New Brunswick in those times, and thus to assure Dr. Gesner that the rocks were Carboniferous.

The limits of the coal formation, as given on this map, do not differ greatly from those obtained by more recent explorations.

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*See Lyell's Principles, Ed. 1835, London; Vol. I, p. 396; Vol. IV, p. 313.

The numerous outcrops of coal which he found, led Dr. Gesner to infer the presence of valuable beds of this mineral within the Carboniferous area ; but the examinations made since in all parts of this tract by the Dominion Geological Survey, and through private enterprise, have not resulted in the discovery of any seams of considerable thickness. Although Dr. Gesner made a rapid traverse across the Carboniferous rocks in Gloucester county, he claims that he did not survey this county, except in the vicinity of Bathurst; and the large wilderness district at the junction of Sunbury, Northumberland and Kent counties was not visited by him. The coloring which he placed on this area expressed his opinion of its probable age, and later explorations have confirmed his surmise that the area was occupied by coal-measures.

That Dr. Gesner attached great importance to the minerals of the coal measures as a source of wealth to the Province of New Brunswick is clear from many statements in his reports. Of the whole of these reports at least one-sixth is devoted to the Coal Measures. Not only did he believe in the existence of valuable beds of coal in the areas where the coal measures were visible, but his error in regard to the Red Sandstone of King's County also led him to infer the existence of valuable coal seams where we now know none such can exist.

New Red Sandstone.

In Dr. Gesner's time the earlier results in the study of geology in England had not been checked or corrected by comparisons with a wider field. The lithological aspect of the rocks, as the Chalk, the New Red Sandstone, the Oolite, were largely depended upon for determining the age of strata. In England the New Red Sandstone was a saliferous formation, and for this reason the saliferous sandstones which Dr. Gesner found in Nova Scotia and New Brunswick were by him referred to the New Red Sandstone or Trias; and being such, of later age than the coal measures.

One belt of these sandstones, however, he referred to their proper position under the name of "Old Red Sandstone," and a few years after his survey closed (1847) he said that the [red] conglomerates along the south side of the coal field might be so classed. This is stated in his book on "New Brunswick," in which he also inclines to defer to the opinion of Sir Charles Lyell, who was "disposed to class these rocks with the Devonian system, or the Permian rocks of Russia." Some years later Dr. Gesner more distinctly avowed this opinion in reference to the corresponding sandstones of Nova Scotia.

There was, however, a modicum of truth in Dr. Gesner's earlier view of the age of the red sandstones, because there are certain small areas among the rocks referred by him to the New Red Sandstone that actually are of Triassic age. These are small isolated patches along the shore of the Bay of Fundy, and perhaps some larger ones on the eastern coast of New Brunswick.

But while we thus gladly give Dr. Gesner the credit of having discovered certain small areas in southern New Brunswick that are truly referable to the New Red Sandstone, there are other larger areas of his map thus colored, that must be removed from this category. Such is the considerable district on the Kennebecasis river and extending thence through Westmorland county. Such, also, is the eastern end of this county; and such, also, two oval areas on Grand Lake in Queen's county. These latter, by the Dominion Geological Survey, are relegated to the Coal Measures, and the two former to the Lower Carboniferous series.

When reduced by the abstraction of these areas, the remaining tracts of New Red Sandstone are quite insignificant, and are strictly confined to the southern coast.

Lias Limestone.

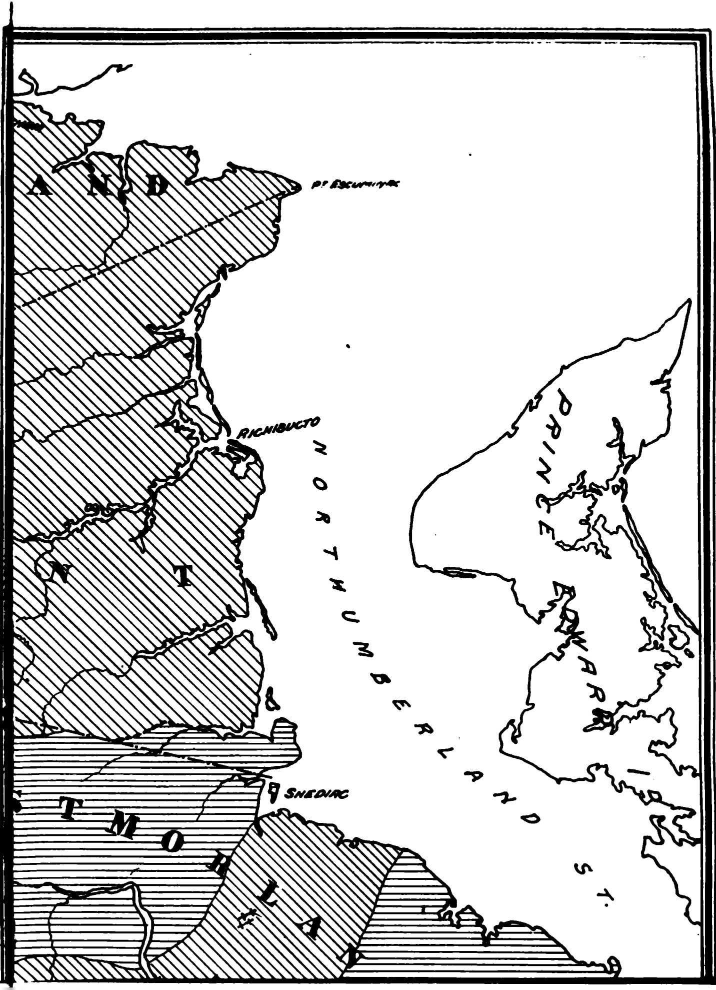
Having found salt springs and gypsum in the red sandstone district of Sussex and elsewhere in Kings county, Dr. Gesner, as we have observed, saw reason to refer the rocks to the New Red, or Triassic Sandstone. Hence he naturally supposed that the limestones which are found in these districts toward the centres of the "New Red" basins were of the age of the Lias of Great

Britain, seeing that they abounded in shells and some of them were of dark color and bituminous. The error was a natural one, though a better knowledge of the bearing and significance of the fossils which he found in these rocks would have corrected it. The genus Productus is so common in these limestones that the modern geologist wonders how the limestone could be mistaken for Lias. Dr. Gesner originated this error in the Carboniferous limestones of Nova Scotia, seen near Windsor, etc. But there there are two sets of limestones quite different in aspect and in the species of the fossils they contain. Of these the lower contains well marked fossils of the Lower Carboniferous, but the upper has many which are very like those of the Permian, the very latest of the Palæozoic rocks. There would be less surprise if these were mistaken for Mesozoic limestones, but there is no such reason applicable to Gesner's Liassic limestone in New Brunswick. We suppose, therefore, that having classed the upper limestones at Windsor as Lias because they overlaid the Red Saliferous Sandstones of Nova Scotia, he applied the same rule to New Brunswick.

In 1843 Dr. Gesner's survey was brought to a sudden and unexpected close, and he never completed the geological map of New Brunswick which he had commenced. This appears from a paragraph in his last report, where he says: "An incomplete geological map of the province is also submitted for your Excellency's consideration. By this it will be observed that the labor of another season will be required to bring the geological survey to a conclusion; and it is very desirable that the undertaking should be finished in the same spirit in which it was commenced." This however was never done.

Dr. Gesner tells us that at the close of his last season's work there still remained to be examined the chief part of the counties of Northumberland, Gloucester and Restigouche.

Dr. Gesner enlivened his geological reports in a way that is not usual now, though common enough in earlier narratives, by introducing descriptions of scenery and incidents of his journeys.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The following may be taken as an instance:

"It is impossible to conceive a more interesting sight than is presented in the Bay [of Fundy] during the summer season. Boats and vessels becalmed and carried away by the tide are at one instant hidden by the blackened rock, or the green foliage of some little island. At another they glide from behind the curtain, and appear, struggling with the overwhelming current. Often several hundreds of boats, huddled together and practising a deadly deception on the haddock and cod, from a signal given by the tide, draw up their anchors and hasten to the shore. The silence of evening is broken by the sound of the Indian's gun, levelled with deadly aim as the rising porpoise. The hollow sound of the "loon's" note is discordant with the scream of the gull. Here the glassy surface of the water is broken by a shoal of herring: yonder the spouting grampus is blowing up the spray in preparation for another dive. * * * The sea is alive with fish, its surface with human beings, and the air with feathered tribes."

Speaking of the shore between Beaver Harbor and Red Head, on the coast of the Bay of Fundy, he says:

"This part of the coast has a very gloomy and forbidden appearance; lofty precipices — shelving and overhanging cliffs — rise abruptly from the sea, and being inaccessible at almost every point, offer no way of escape for the unfortunate traveller who might be landed beneath them. There are also deep caves and wide chasms, where but a few rays of light ever enter, and no sound can be heard but the murmurings of the sea, ever washing their deepest vaults. That these openings were formed by earthquakes there can be no doubt, as the walls on either side clearly show that they were once united. The examination of such places is not free from danger on account of the violence of the waves, and the detached pieces of rocks, constantly falling from the cliffs above."

From Dr. Gesner's narrative we may judge that he met with many obstacles to his progress, due to the wild and unsettled condition of large tracts of the country, and to the imperfect means of communication. Of his journey on the St. Croix and Eel rivers, along the western boundary of the province (see sketch-plan of his journeys facing the title-page), he says:

"Having procured three expert Indians with canoes, and being accompanied by my son and Mr. Charles Ketchum, a volunteer — with a sufficient quantity of provisions and the requisites for encampment, a portage of twelve miles was made from St. Stephen to the Upper Schoodic or Grand Falls. * * * About six miles above the Little Cheputnecticook Falls the river expands into a lake surrounded by a tract of low ground called Porter's Meadows.

"Above this, four miles (out of eight) are occupied by rapids, the most dangerous of which are the Elbow Rips at the foot of the Lower Lake. Our canoes were pushed up over an evenly inclined plain two miles long, where all our strength and skill were required to overcome the swiftness of the current. After much labor and difficulty the light barks were urged upward over the last rapid, and we paddled along the surface of the lake where the water is quiet and its gloomy stillness is strongly contrasted with the roaring of the river below. * * *

"We next encamped at the east side of the North Lake, where there is a portage to Eel River Lakes. The difficulty of discovering an old Indian path through the woods is always great to the unpracticed; and as the portage trail had become obscured by the growth of grass during the summer, and none of our Indians had ever passed this route, it was feared that the advantage of the path for carrying the canoes and baggage would be lost, and we should be obliged to steer through the thick forest by compass. From this embarrassment I was relieved by the discovery of some Indian hieroglyphics upon a tree, which expressed clearly the necessary information. On the clear wood of a large cedar there was clearly marked in a peculiar black and durable ink an Indian carrying a canoe; and the direction of the figures was exactly that of the portage; so that the old winter paths of the lumbermen were readily avoided. Two deer, with an Indian presenting his gun at them, were also exhibited, indicating to the traveller to look out for these animals; the the information was important and found to be strictly correct.

"The trail is a deep and narrow path, worn out by human feet, and at some places the solid rocks were found to be furrowed by the moccasins of our native tribes. After carrying our canoes across this portage, we again embarked for the exploration of the rocks of the Eel river and its lakes."

Another instance in which Dr. Gesner found the benefit of Indian pictorial representation was when his party was about to descent a dangerous rapid and fall on Eel river. Here they saw a large drawing of two Indians with their heels uppermost and their canoe capsized, executed in black ink on a broad piece of cedar fixed to a post on the bank of the river.

Difficulties with his Indian guides prevented Dr. Gesner from carrying his exploration of the Tobique to a completion.* He had at this time reached the forks of the Tobique where it parts into four branches; at this point one of his Indians had deserted and the rest refused to proceed further into the wilderness, with a short stock of provisions and with shattered canoes. He was therefore reluctantly compelled to return. Generally, however, he found the Indians willing and intelligent guides.

Dr. Gesner's scientific activity did not cease with his work on the Geology of New Brunswick, for about this time he must have written a memoir on the geology of Nova Scotia, accompanied by a geological map of that province, showing an advance on his earlier work there by the delineation of the crystalline axis of the Cobequid hills. That he was still thoroughly imbued with the belief that the gypsiferous sandstones of these provinces were not Carboniferous is shown by this map, in which they are represented as Devonian, or Old Red Sandstone.

This memoir (or an abstract of it) was published in the Proceedings of the Geological Society of London (Vol. IV, Pt. I, No. 95, 1843), and curiously enough the same number of this journal contains an article from the pen of Sir Charles Lyell, "On the Coal Formation of Nova Scotia, and on the Age and Relative Position of the Gypsum and accompanying Marine Limestones." Both from palæontological and stratigraphical considerations Sir Charles adduces convincing reasons for placing these gypsiferous sandstones in the Carboniferous system beneath the coal measures.

Sir Charles also describes a newer red sandstone without fossils on the Salmon river, near Truro, resting unconformably upon the edges of the Carboniferous strata; this we now know to be of the age of the Red Sandstones of the Annapolis valley, which are universally recognized as Mesozoic.

Except for the error in regard to the age of the red sandstones, this later geological map of Nova Scotia of Dr. Gesner is much in advance of his earlier one.

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* **Fifth Report, p. 82.**

"New Brunswick."

In the course of Dr. Gesner's geological survey of New Brunswick, he picked up a great deal of information on its natural history and resources. This information he embodied in a work published in London a few years after the close of his survey, bearing the above title.*

The first three chapters are given to the history of the province, first as a part of ancient Acadia, and then as a part of the Province of Nova Scotia, and finally as a province by itself. Another chapter is given to the boundary disputes and a general description of the country, and a fifth chapter to the native Indians or aborigenes of the province.

This chapter describes the character, customs, dress, dwellings, etc., of the two tribes which have inhabited the province since it became known to Europeans.

A long chapter is devoted to a description of the topography of the province, that of each county being given separately, with valuable information relative to the settlements, lumbering, soil, minerals and fisheries. Agriculture forms the subject of another chapter, in which the climate is favorably spoken of, the forest trees described, and directions are given for applying manure and clearing up the wild land.

The author devotes considerable space to an historical account of the colonial fishing rights and of the aggressions of the American fishermen. The timber trade, the manufacture of lumber and the export trade in this commodity, also receives much attention from Dr. Gesner in this book.

The next chapter treats of the population of New Brunswick, and of its religious, social and political status. An examination of this chapter will show the great increase in the material prosperity of the province since this book was written. The imports and exports have greatly increased, and there has been a like increase in the material comfort and prosperity of the people. There has been some change in the denominational status of the population. The number of clergy of the Church of England has more than doubled. The relative change in numbers of the Roman Catholic population, then imminent, has come about, and they are now the most numerous of all the Christian bodies. The Baptists and Methodists have greatly increased. King's College, established in 1828, had been thrown open to all denominations, but there still remained a course in divinity in connection with the Church of England. The social conditions of the population in New Brunswick half a century ago, as described in this book, contrast greatly with the existing state of society. The isolation of the people in the winter time no longer exists; and social pleasures are not now, as then, so much limited to the coldest season of the year. Nevertheless, according to this author, the City of St. John at that day had grown from its foundation by the Loyalists sixty years before to a population of 26,000 souls. The revenues of the city were only £5,000 per annum; a contrast to the large amount collected for civic purposes at the present day.

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* New Brunswick, with Notes for Emigrants, by Abraham Gesner, Surgeon, F. G. S., etc., London, 1847.

In speaking of "society" in St. John and Fredericton in those old colonial times, Dr. Gesner says:

> "There is a constant struggle between the aristocratic principle and the spirit of freedom and equality characteristic of the American. Persons who have risen from the lower ranks, and have arrived at affluence, are apt to overrate their importance; and such as have the advantage of birth and education are frequently supercilious. It is to be regretted that from these causes endless jealousies arise, and society is divided into small circles and parties."

The author of "New Brunswick" devotes a short chapter to the geology and mineralogy of the province, and another to its natural history; and the work closes with "Notes to Emigrants."

"INDUSTRIAL RESOURCES OF NOVA SCOTIA."

The next important work published by Dr. Gesner was a volume of 375 pages on the "Industrial Resources of Nova Scotia."

This work opens with an historical sketch of the province, beginning with the early French settlement of the country and extending down to the time in which Gesner lived. This is followed by a geographical outline, giving an account of the harbors, lakes, marshes, etc. In another chapter the vegetable products of the province are described, and then in succession the fisheries, agricultural capabilities, manufactures, geology, mines and minerals. Chapter X gives an account of the climate, history and resources of Cape Breton; and there is a final chapter devoted to prospective railways and to emigration.

This book is imbued with the local politics of the time at which it was written. It advocates the protection of the sea-fisheries from foreign aggression, complains of the monopoly of the mining rights, and calls for the construction of a railway from Halifax along the Gulf shore of New Brunswick to the Metapedia river and Quebec. This railroad has since been built almost exactly on the line advocated by Gesner.

One remarkable feature of the book is the strong advocacy of a protective policy in relation to the commerce and manufactures of Nova Scotia. It outlines the "national policy" adopted by the Canadian confederation soon after the consolidation of the provinces. The policy of protecting domestic manufactures was adopted in New Brunswick about this time, but soon after abandoned for a tariff purely for revenue.

The geological chapter may be considered to contain Dr. Gesner's matured views on the geology of his native province. Thirteen years had elapsed since the issue of his work on the Geology and Mineralogy of Nova Scotia, and several able geologists had in the meantime given their attention to the geology of Nova Scotia.

The views expressed in this work differ in some points from those of the earlier one. His first division consists of granitic or hypogene rocks, and as he speaks of the associates of the granite he also would include the gneisses and mica schists. He now describes the clay slates and quartzites of the primary district and those of part of his former "clay slate district" as *Cambrian*—a natural out-growth of the improvement of geological nomenclature, and parallel to his recent work in New Brunswick. Under the head of *Silurian Group* he includes the remainder of the "clay slate group" of his first book on Nova Scotia. His fourth group is the "Old Red Sandstone," or Devonian group, for the red rocks that were found below the coal measures, etc. This is merged in the Lower Carboniferous by later writers. The fifth division is the "Carboniferous rocks or coal formation." The sixth is the "New Red Sandstone." This division, extensive in the former work, is now limited to certain strata near Truro. The seventh group is the "Intrusive and Igneous rocks" of the North Mountains. The eighth is the Boulder or drift formation. This group was not recognized in the earlier work, for in that the surface deposits are mentioned casually in connection with the coherent rocks of the older formations. Dr. Gesner attributes both the unstratified and stratiged drift to the action of water, manifested through ocean currents, floe ice, etc.

Over thirty pages of this work are devoted to a description of the economical minerals of Nova Scotia, with statistics of the exportation of coal.

Dr. Gesner lived in a period when the science of geology was in its infancy. Hence we see proof, as we peruse his works, of the gradual acquisition of new ideas upon the theoretical part of the science. Now a geological surveyor enters upon his work after a long course of preliminary training ; then he had to make himself acquainted year by year with the rapid development and new phases of thought in his favorite science. Now he enters the field provided with the stores of knowledge accumulated in the last one hundred years ; then he was slowly gathering those facts and observing those phenomena which lie at the base of geological theory.

We cannot judge Dr. Gesner by modern standards, but by the criteria of the times in which he lived; nor should we omit from consideration the slowness and difficulty of communication in those times. Knowledge of the kind required by the geologist was not disseminated in those days by the magazine and scientific journal; there were no great schools for investigation and for teaching the science to the same extent as now; and for those who lived far from the active centres of thought the attainment of exact knowledge in natural science, and especially of its new discoveries, was slow and difficult. Hence we should give Dr. Gesner full credit for the good he accomplished and excuse the mistakes and deficiences incident to his times and position. That his later life was to some extent clouded cannot but be a matter of regret to those who witnessed his zeal in pursuing the chief object to which he devoted himself, viz.: the development of the natural resources of his native country. That he struck out the main geological features of the maritime provinces of Canada correctly there can be no question, that he committed errors of detail is also undeniable, but this is what every geological surveyor who works in a difficult and complicated region is liable to do.

He recognized what would now be termed the Pre-carboniferous "massif" or "complex" of these provinces in the complicated rocks of the several bands of crumpled and more or less metamorphic rocks which traverse them. These he included under the name of Graywacke system, referred by him at one time to the Silurian, but finally to the Cambrian age; and as regards the northern metamorphic belt in New Brunswick in part to the Silurian. This massif or complex is now known to contain rocks ranging from the Laurentian to the Devonian.

He recognized as overlaying these a mass of secondary strata consisting of softer and unaltered rocks as covering extensive tracts in these provinces. These he referred to three geological systems—the Old Red Sandstone, the Coal Formation, and the New Red Sandstone. His Old Red Sandstone is now regarded as Lower Carboniferous, and while we retain his "New Red" Sandstone, we eliminate from it large areas which he supposed were of this age, and refer them to the Carboniferous system.

Gesner thought he found Tertiary deposits in certain places along the coast, but as these contain marine shells, all of living species, it is evident they are of later date than he supposed, and should be referred to the Quarternary age.

Though Gesner outlined correctly in a general way the geology of the Maritime Provinces, his work cannot be accepted in all its details, as his methods were not sufficiently exact for modern requirements, and notably, in the department of Palæontology. We should, however, in estimating its value, bear in mind the difficulties he had to encounter, and the short time at his disposal for the exploration of a province mostly covered with forest, with few exposures, except on rapid streams, and along the coast, and with means of transportation imperfect and tediously slow. We should rather wonder that under these circumstances he was able to accomplish so much, and to inspire an enthusiasm for geology which has borne fruit until the present day.

SUPPLEMENTARY.

The Gesner Museum. A Corresponding Member of the Natural History Society, Henry F. Perley, C. E., writes to me to say that he remembers well the formation of the Gesner Museum, and how it expanded until it out-grew the house,* and quarters had to be taken for it in the upper story of a building on Prince William Street, near where McMillan's bookstore now is. Mr. Perley remembers, as a very little boy, attending a course of lectures given by Dr. Gesner in 1841, in a building just south of the corner of Germain and King Street (" Foster's Corner ").

Dr. Gesner involved himself in considerable expense in collecting and arranging his museum, and it was sold to a company of gentlemen in St. John, who deposited it in the Mechanics' Institute (then a new building) on certain conditions and with reservation of rights to have it open to the public. Many of the owners gave in their shares to the Institute, and this institution came in time to be considered the owners. When this body was dissolved, the Gesner Museum with the collections which the Institute had added to it, was purchased by the Natural History Society of New Brunswick, and added to their museum.

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* Where Dr. Gesner lived, near the corner of Coburg and Hazen Street.

The most valuable parts of the Gesner and Institute Museum are the ethnological collections now in the lecture hall of the Natural History Society, and the collection of minerals from the Jurassic Trap of Nova Scotia, made by Dr. Gesner. The collection of birds and mammals has been superseded in importance by that of the Natural History Society. The minerals are kept in a room called the "Gesner Museum."

The Albert Mine Case. Early in the "forties" a peculiar mineral was discovered near Hillsboro in Albert County, N. B., which was claimed to be coal, and a license was obtained to mine it. Gesner contended that it was not coal, but asphaltum, and obtained a license to mine this mineral. The contending parties laid their claims before the court at Halifax and a long trial was the result: both sides brought expert testimony; Dr. C. T. Jackson and Dr. A. A. Hayes of Boston, and J. G. Percival of New Haven, were brought to show that the mineral was coal. R. C. Taylor and Prof. Jas. Robb were the experts called by Gesner and his associates to prove that the mineral of the Albert mine was asphaltum. After long argument on both sides, when the question was passed to the jury, the judge drew attention to the fact that the license to mine coal included "and other mines and minerals," and stated that the substance was a mineral. On this point the question was decided in favor of the defendants, and Gesner lost his case; though there is no doubt his contention was right, for the mineral is not a coal, but a variety of asphaltum (melan-asphalt).

Dr. Gesner was appointed Commissioner to the Indians in Nova Scotia, and in 1847 made a report on their condition to the provincial government.

Other Publications. To the list of publications referred to in this article, or mentioned in that published in Bulletin No. XIV., the following may be added — Geology of New Brunswick, Nova Scotia and Prince Edward Island, Fisheries of the Provinces; Practical Treatise on Coal, Petroleum and other Distilled Oils.

ARTICLE II.

DESCRIPTION OF AN EXTINCT PALÆOZOIC INSECT, AND A REVIEW OF THE FAUNA

ERRATA OF ARTICLE II.

Page.	Line	
51.	28.	For, "the Upper," read referred to the
51.	31.	Erase "Upper"
52.	1 and 6.	Before Devonian, insert, Eo-
53.	17.	After "links" insert, between the Myriapods of the two systems
53.	18.	After "Arachnoids," insert, (also similar to those of the Coal Measures)
55.	25.	For "foaward," read, forward.
59.	8.	After wherein, insert, all.
59.	19.	After "5," insert, after Dawson.
60.	27.	For "next" read, Myriapods.

the Carboniferous age, and even before the later Devonian, and includes types which are strange to the student of the Carboniferous land fauna, and still more so to the investigator of modern species.

In presenting figures of these types we have added to them two objects, claimed to be insect wings, of equal or greater antiquity; and have also inserted the form of a gigantic insect that lived in the Carboniferous age, which was found at Commentry, in France, and has been described by C. Brongniart. This insect, which was nearly a foot and a half long, is given for comparison of the venation of its wings with those of the insects of this ancient fauna of eastern Canada.

At the end of the article is the description of the new species of insect — a Thysanuran.

Of the two objects referred to above, the most ancient fossil is that lately described by Dr. J. C. Moburg, from the Lower Graptolite schists (Arenig age) of Sweden, and supposed to be the wing of a bug. This fossil is very much older that those of the Canadian strata, but the characters are obscure; and although several Swedish and Finnish naturalists, who have seen the fossil, are inclined to concur in Dr. Moburg's statement that it is the wing of a Hemipter, or Bug, the object is not very clearly of this origin, and the confirmatory evidence of other organisms of a similar kind, is lacking. Its occurrence in Graptolite schists, which are open ocean deposits, is also against the view that it is an organism of the land. If such, it must have floated out to sea a long distance, and have escaped the sharp eyes and hungry maws of the scavengers of the deep.

Elsewhere in the world there has been one other object found which is claimed to be an insect wing of great antiquity. A figure of this fossil is given in the accompanying plate, and it seems to be of about equal age with the insect remains at St. John. This fossil is the *Palæoblattina Douvillei* of C. Brongniart from Calvados in France. Mons. Brongniart considers it to be the wing of an ancient cockroach, and in a general way it seems to be similar in venation to wings of that family of insects; but the peculiar way in which the anal and interno-median veins become confluent along the lower border of the supposed wing, is unusual in ordinary insects. In this case, as in that in Sweden, there is no confirmatory evidence from associated animals, or surrounding conditions, to show that this object is the wing of an ancient cockroach.

The real significance of the primitive land-fauna in the beds at St. John will be better appreciated if we sketch briefly the physical conditions of the early Palæozoic time in Acadia (the Maritime Provinces of Canada.) It would seem that the oscillations of the surface of the earth in this region had a rule of their own, different from that in Europe, so that the geological terranes here do not correspond to the geological systems of

Europe. Thus our Cambrian terrane includes the Lower Ordovician, and we have no trace of the Upper Ordovician over a large territory in eastern North America, including Acadia, and most of New England.

The next terrane includes the Silurian (Upper) and the Eo-Devonian (Oriskany) and its deposits are spread over Acadia, but not in an equal manner, some areas having been above water through a considerable portion of the time when this terrane was forming, and other portions, that were submerged at the beginning, arose above the sea during its progress. Hence we find that in some areas the terrane begins with the base of the Silurian (Medina and Clinton) and in others not until the Eo-Devonian (Oriskany). The Lower Helderburgh Fauna has not been recognized in this region, so that the groups known by marine fossils are the Clinton, Niagara and Oriskany. Throughout this terrane there are more or less of remains of a flora which, we may surmise, originated on the great emerged area of this part of the earth that was above the sea in later Ordovician times. The first traces of it that we have are found in beds of the age of the Clinton. It reaches its full measure in the Niagara period, and continues to be represented by many of the same species in the higher beds, thus extending up into the Devonian.

Great disturbances occurred after the Oriskany beds were deposited, and the region was subjected to violent earth movements, with intense pressure, and the eruption of granitic rocks. The terrane which preceded or accompanied this time of disturbance is the Upper Devonian, and consists of coarse conglomerates and red slates ; in the conglomerates are fragments of Silurian (Upper) corals, in the slates obscure remains of plants.

Upon these Upper Devonian rocks, after their elevation and folding, was laid down the Lower Carboniferous conglomerates and shales containing a fauna and flora very different from that of the older time. The condition of the Carboniferous beds indicates the removal of the pressure which had plicated and altered the older rocks, though volcanic eruptions continued to occur to a more limited extent.

The Silurian-Devonian terrane is composed of three principal members, of which the two lower, by their marine faunas, are Silurian, and the upper apparently corresponds to the Eo-Devonian terrane on the south side of the Bay of Fundy.

The land fauna is found in the middle member of this Siluro-Devonian series, and briefly the following is an outline of the conditions marked by the several terranes resting on the St. John group.

At the top are:

Red sandstones with overlying conglomorates. These are equivalent to those of Nova Scotia, which are called Triassic and Jurassic.

A marked unconformity occurs here.

Beneath these are:

Coal measures, etc. Beds horizontal or inclined at low angles. Containing the Coal Flora.

Lower Carboniferous Conglomerate and Shale. More disturbed. Containing a Flora allied to that of the Devonian. The coals are *bituminous.*

An unconformity occurs here with great erosion and extrusion of granite.

Devonian Conglomerate and Shale. No distinctive fossils known. Plant remains of this terrane and all below are *non-bituminous.*

Unconformity with much erosion.

LITTLE RIVER GROUP.

Upper Cordite Shales (Eo-Devonian ?) The Flora of the Plant Beds continues up into this group.

Lower Cordaite shales, Silurian. Appearance of the typical Flora of the Plant Beds in bed No. 2. *This is the place of the Land Fauna, described and figured in this article.*

Dadoxylon Sandstone, Silurian. An earlier Flora here, including that of Plant Bed No. 1.*

Bloomsbury Conglomerates (local) resting on old eroded land surfaces.

Marked unconformity to the St. John Group, etc.

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* Spoken of in Transactions Royal Society, Canada, Vol. VI., Sec. iv., p. 61 (at bottom) as a Devonian Flora.

In this little oasis at St. John which formed a refuge for the air-breathers of Silurian time, there no doubt was a much greater variety of animals than we know of at present, but it is questionable whether a single vertebrate of the land was then in being, and it is quite sure that none has been recovered. Vertebrates, in the form of small mailed fishes, were living in the estuaries around the borders of the land, but probably none were adapted for locomotion over a dry surface, and so we have no terrestrial vertebrates in the Silurian age.

The bulk of the land fauna consisted of air-breathing articulates, some of which are of novel and bizarre types, others like forms found in the Coal Measures, but all widely divergent from any living types.

The large proportion of millipedes and centipedes is remarkable; they form a quarter of the fauna, are mostly of large size, and several of the genera are like those of the Coal Measures. If we had not these genera to supply intermediate links no one would recognize in the Arachnoids, the scorpions and spiders of modern times. We have attempted a restoration of one of the forms related to the spiders on the basis of the specimen preserved, and of some Carboniferous forms described by Dr. S. H. Scudder. The way in which the thorax grades into the abdomen, though seen to some extent in the Carboniferous forms, is more complete in those of the St. John beds.

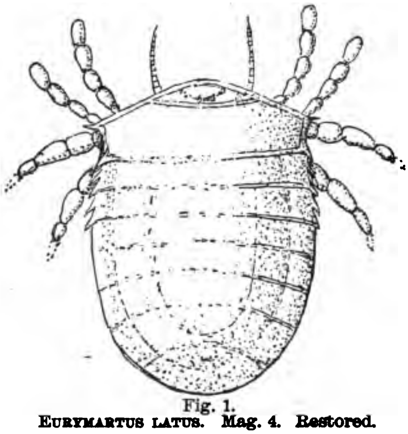

Fig. 1.
EURYMARTUS LATUS. Mag. 4. Restored.

An order of insects which is insignificant in the modern world—the Thysanura—had a larger proportion in this ancient fauna. These insects, by their want of wings, the absence of a distinct division of the body into three regions, and the uniformity of the segments of the body, show a low type of structure, and an approach to the primitive insectean forms. A restoration of one of these insects is given here, and the full description of another (with a figure of the same) is given on a following page.

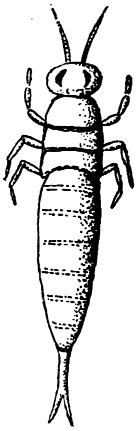

Fig. 2.
PODURITES SALTATOR. Mag. 2. Restored.

Perhaps a higher interest centres in the winged insects of this early time than in the wingless creatures described above. Among these air-breathing insects none of the modern orders of insects are present. Among the missing are the Hymenoptera (bees and wasps), Lepidoptera (butterflies and moths), Diptera (flies); even the Coleoptera (Beetles) have not been recognized. The remains found are all of such insects as go through only a partial metamorphosis, like the Orthoptera (grasshoppers and crickets) and Neuroptera (dragon flies, etc.) Among these fossils we find examples of a family comparatively rare now, but then apparently plentiful—the Phasmidæ or Walking-Sticks. A gigantic May-fly, also, is known from these early beds.

The presence of a small scorpion, two little snails and some articulates of doubtful affinities serve to add further to the variety of types of land-animals in these strata, and tell us of the life of the world in Silurian times.

The remains recovered from these beds consist of about two dozen forms of animals; and when it is known that with scarcely an exception, *only one individual of a species has been recovered*, it will be seen that the objects figured in the accompanying plates represent only a mere fraction of the great number and variety of air-breathing articulates that must have existed in Silurian time, even at this one locality. The air must have been alive with winged insects and the plants and ground must have teemed with crawling creatures of strange and surprising shapes.

GERACUS TUBIFER. n. sp.

Apterous. Body obscurely divided into three regions of head, thorax and abdomen; somites of the head cemented and fused (?) with the prothorax, all the others separate, and approximately of equal width.

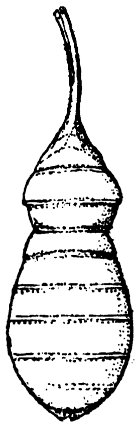

Fig. 3.
GRACUS TUBIFER.
n. gen. and sp.
mag. 4.

Head conical, prolonged into a tube or proboscis, which is thrice as long as the rest of the head (and of separable parts ?). No eyes or antennæ are recognizable.

The rest of the thorax consists of two separate rings of subequal length; of these the mesothorax is wider than the other laterally. The metathorax narrows backward at the sides, and at its posterior edge the body of the insect is narrowest. Under this interpretation of the thorax, we suppose the prothorax fused with the head, or suppressed. The legs are unknown, except that there is an obscure impression of the second one on the right side.

The abdomen is ovate and somewhat pointed behind, and consists of six joints. The first ring of the abdomen has the posterior margin pushed forward in the middle. The three next have directly transverse margins, but the line dividing the fourth and fifth joints is slightly arched foaward in the middle, and these two joints may be anchylosed. At the back of the last joint is a narrow obscure slope, slightly emarginate. No appendages are visible.

Size. Length 13 mm. Length of head, including the tube, 4 mm.; width 2 mm. Length of thorax 3 mm.; width 3 mm. Length of abdomen 6 mm.; width 4 mm.

Horizon and Locality. Dark shales of Plant Bed No. 2, Lower Cordaite shales of the Little River Group. Lancaster, St. John County, N. B. Rare.

Condition of Preservation. This fossil presents the brownish-black, shining surface, characteristic of the insects and myriapods of this locality. In lustre and hue they differ from the plant remains, which are of a pure grey and more lustrous, often brilliantly so, on account of their graphitized surfaces.

The body of this insect is cracked longitudinally and flattened by pressure. On the right side the margin is perfect throughout, but on the left it is broken away, or crushed in, from the head to the second joint of the abdomen; on this side also the margin is slightly pushed in at the last two segments. These defective parts are restored in the figure.

Comparisons with other Species. Such is the peculiar aspect of this fossil that only with hesitation can one refer it to any existing order of insects. There are apterous forms among the Hemiptera which may seem to have points in common; such are the lice, but in these the sucking tube is soft, whereas in Geracus, judging from its distinct preservation in the stone it consisted of hard chitin, and the head is not distinctly separated from the thorax.

There is a superficial resemblance in the conical head and long proboscis to the weevils among the Coleoptera, and the small number of rings in the abdomen is also a feature in which it resembles these compactly built little insects, but the loosely-jointed body is quite at variance with the structure of the weevils; and there were no wings.

As regards the size and to some extent the form of the head, Geracus compares with more than one of the Palæozoic insects. Thus *Lithomantis carbonaria* Wood, from the Carboniferous of Scotland* has a small pointed head with an elongated anterior process; and a similar head, but with a long lance-like sucking tube belongs to *Eugereon Boeckingi* Dohrn, of the Permian of Germany;† this tube is about the same proportionate length as that of Geracus. In both these insects, however, the head is distinctly separated from the thorax, and not connected by a broad base as in our species; they also have transversely oval prothoraces.

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* Quart. Jour. Geol. Soc. London, Vol. xxxii., pl. 9, 1876.

† Palæontograph. Bd. xiii., Taf. 41, Cassel 1866.

The sum of characters in Geracus undoubtedly point in the direction of the Thysanura, especially if we include in this group that remarkable insect which inhabited the ancient lake basin of Florissant, described by Dr. Scudder under the name of *Planocephalus ascelloides.** (See figure below).

The Thysanura are distinguished among insects by the loose aggregation of the body rings, and the imperfect specialization of the thorax and abdomen. As Dr. Scudder has well remarked, they in this respect, more than other insects, approach the Myriapods; and like these are devoid of wings.

The Podura or Springtails, a section of the Thysanura, are notable for their compact bodies, especially the abdominal part, and for the few rings of which the latter region is composed; in these respects they are constituted similarly to Geracus.

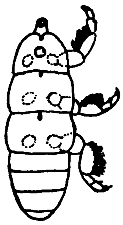

Fig. 4.
PLANOCEPHALUS ASCELLOIDES.
Mag. 3. Restored.

But while the modern Spring-Tails illustrate some points of structure in this Acadian genus, others are more strikingly paralleled by Dr. Scudder's extinct genus, Planocephalus. This remarkable genus differs from other active insects in the reduction of the cephalic region to a proboscis with masticatory plates at the orifice. The proboscis was capable of being withdrawn under the thorax or could be projected the full length of the body; when thus projected the head and oral tube must have presented a close resemblance to that of Geracus.

In the thoracic region the resemblance was not so close, as here the Acadian genus more nearly resembled the Podura and the higher insects.

The abdomen of Geracus by its compactness is like that of Scudder's headless genus Planocephalus, but has two joints more, and by this and by its form is near *Iotoma plumbea* Packard,† among the Thysanurans.

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* U. S. Geol. Surv. Vol. xiii. Tertiary insects of North America, S. H. Scudder, p. 94, Figs 1-3, 1890.

† Guide to the Study of Insects, p. 626, Pl. 10, Fig. 6 and 7, New York, 1880.

The variety of forms which now begin to be associated together in the Thysanura, give support to Dr. Scudder's suggestion that this group may be regarded as one of "equivalent taxonomic value to the larger divisions of winged insects."* As we learn more of the Palæozoic insects we are likely to find this group one of greater importance than we could suspect it to be from our knowledge of its prominence in the present age of the world. In this connection it is a matter of some significance, that in the insect fauna of the Little River group, the oldest known up to the present time, the only insects (three in number) whose bodies are known, are wingless, and *two of them are Thysanurans;* while the third was a lowly form, loosely articulated, and with body rings very uniform in aspect, described as the larva of a Neuropterous insect, but also possibly a Thysanuran.

Some time ago the writer met with the description of a strange aquatic insect (or insect larva), having jointed dorsal appendages, observed by Miss Adele M. Field at Swatow, in China. (See plate I, fig. 12). It was found in still pools of fresh water, crawling slowly on water plants. It appeared to feed on microscopic objects (heliozoans, rotifers and infusoria). Exuviæ of varying size found in the water they inhabit, show that they moult. The head is flat and has eyes and antennæ, but is very small and almost reduced to a sucking tube; the thorax has three segments, bearing paired legs; the abdomen has nine segments which bear long slender jointed appendages containing tracheæ. The abdomen was terminated by two sharp, jointed styles, nearly as long as the body. In its general form this insect resembles Archæoscolex (plate II, fig. 9), in its microscopic head Geracus (see fig. 3 above), and in the stylets, Podurites (pl. II, fig. 8). It is only in such rare and exceptional examples as this Chinese insect that we find modern forms explanatory of these strange creatures with which the Reign of Life on the land began.

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* Op. cit.

The following list will serve to explain the accompanying plates and at the same time show the number and the affinities of the several species of this fauna. References are given to the works where the species are described.

INDEX TO THE LAND FAUNA OF THE LITTLE RIVER GROUP AT ST. JOHN, N. B., CANADA.

(N. B.—The numbers in the margin refer to the several figures in the two plates (and one in the text) wherein the known forms of this Fauna are shown.

PLATE.	FIGURE.	MOLLUSCA. (Land Snails.)
II.	18.	*Strophella grandæva*, Dawson. Mag. 5⅔. Am. Jour. Sci., Vol. xx. p. 413.
I.	1.	*Pupa primæva.* Mag. 4. Trans. Roy. Soc. Can., Vol. xii., Sec. iv., p. 100 (1894) — 1*b*, surface further enlarged.
		CRUSTACEA. (Saw Bugs?)
II.	4 and 5.	*Amphipeltis paradoxus*, Salter. Jour. Geol. Soc. London, Feb. 1863, and Trans. Roy. Soc. Can. 2nd Series, Vol. 1, Sec. iv., p. 278, Fig 4. Mag. 1⅓; Fig. 5. Reduced ⅔.
I.	4*a* and *b*.	*Eurypteris pulicaris*, Salter. Ibid. This species is supposed to be founded on the body segments of two insects or myriapods. The objects are enlarged respectively 1⅓ and 2 diam.
		ARACHNOIDA. (Scorpions and Spiders).
I.	2.	*Eurypterella ornata* (Geralinuridæ?) Mag. 2⅔. Trans. Roy. Soc. Can., Vol. vi., Sec. iv., p. 60 (1888).
I.	3.	*Palæophonus arctus* (Scorpion). Mag. 2⅔. Ibid. Vol. xii., Sec. iv., p. 100 (1894).
II.	1.	*Eurymartus latus.* Mag. 2⅔. Trans. Roy. Soc. Can. 2nd Series, Vol. i., Sec. iv., p. 275 (1895).
II.	2.	E——(?) *spinulosus.* Mag. 2⅔. Ibid. p. 276.
II.	3.	E——(?) sp?——. Mag. 2⅔. Ibid. p. 277.
		MYRIAPODA. (Earwigs, Millipedes).
I.	10.	*Palæocampa* (?) *obscura.* Mag. 1⅓. Trans. Roy. Soc. Can., Vol. xii., Sec. iv., p. 108 (1894),
I.	7 and 7*b*.	*Euphoberia atava.* Mag. 1⅓. Ibid.—7*b*, two legs, further enlarged.
I.	8,	*E*—— sp.? ——. Mag. 1⅓. Ibid. p. 109,

MYRIAPODA. (Earwigs, Millipedes).

PLATE.	FIGURE.	
I.	5.	*Ilyodes (?) attenuata.* Mag. 2. Ibid.
I.	6.	*Eileticus (?) antiquus.* Mag. 1⅓. Ibid.
I.	9.	*Chilopus dubius.* Mag. 4. Ibid, p. 110.

INSECTA-THYSANURA (Springtails, etc.)

II.	8.	*Podurites saltator.* Mag. 1⅓. Trans. Roy. Soc. Can., 2nd series, Vol. i., Sec. iv., p. 273 (1895).
Text	3.	*Geracus tubifer.* Mag. 4. Described at page 55.

INSECTA-PALÆODICTYOPTERA.

II.	11.	*Homothetus fossilis.* Scudder. Mag. 1⅓. Can. Nat., n. s. iii, p. 205 (1867).
I.	11.	*H—— erutus.* Reduced ⅔. Trans. Roy. Soc. Can., Vol. xii., Sec. iv., p. 95 (1894).
II.	12.	*Geroneura Wilsoni.* Mag. 2 + Ibid. Vol. vi., sec. iv., p. 57 (1888).
II.	13.	*Lithentomum Harttii,* Scudder. Reduced ⅔. Can. Nat., n. s. iii., p. 206 (1867).
II.	14.	*Xenoneura antiquorum,* Scudder. Reduced ⅔. Ibid.
II.	15.	*Gerephemera simplex,* Scudder. Reduced ⅔. Geol. Mag., Vol. v., p. 175 (1868).
II.	16.	*Dyscritus vetustus,* Scudder. Reduced ⅔. Ibid, p. 176.
II.	9.	*Archæoscolex corneus.* Mag. 1⅓. Trans. Roy. Soc. Can., Vol. vi., Sec. iv., p. 59 (1888). (To this section or the next).

OBJECTS FROM OTHER TERRANES, FIGURED FOR COMPARISON.

II.	10.	*Titanophasma Fayoli,* Brongniart. Coal measures, Commentry, France. Reduced 5⅓.
II.	7.	*Palæoblattina Douvillei,* Brongniart. Reduced ⅓. Middle Silurian, Calvados, France.
II.	6.	*Protocimex siluricus,* Moberg. Mag. 4. Lower Ordovician, Killeroed, Sweden.
I.	12.	A recent aquatic insect (or insect larva) from ponds, Swatow, China. Mag. 2. The small projection at the anterior end is the head.

ARTICLE III.

NOTES ON INTRUSIVE ROCKS NEAR ST. JOHN, N. B., CANADA.

BY W. D. MATTHEW, PH. D.

Read 4th May, 1897.

[The following notes are in continuation of an article read before this Society 8th May, 1894 (See Bulletin No. XII., 1894) For the preparation of the sections on which the following observations are based, the author is indebted to the Laboratory of the School of Mines of Columbia University, New York, and for several of the rock specimens examined, to Prof. L. W. Bailey, of the University of New Brunswick, Fredericton.

No. 1 of the following list is similar to a granitic rock on Long Island, opposite Barlow's Bluff, which rock is in contact with slates and limestones of the Upper series (Grenvillian) of the Laurentian.

Nos. 2, 3, 4, 5 and 6 are intrusions in the slates and flags, (Division 2) of the St. John Group (Cambrian). Nos. 78–187 are from a mass, forming a rather prominent hill, called the Devil's Back, on the north shore of the Long Reach of the St. John river, which is bordered to the north and west by red sandstones of the Etcheminian series (Palæozoic but pre-Cambrian). This mass is similar to some others along the Long Reach which appear to have come through Silurian (Upper) beds.

Nos. 69–76 and 72–15 are igneous rocks bordering the granite and which are in contact on their south side with Silurian (Upper) shales and sandstones. The age of these shales, etc., is determinable from fossils which they contain in some places not far from the igneous rock.

The name "Ox-bow," used in connection with one of these rocks, was applied to a sharp bend in the "Nerepis" Road at the locality designated. This road is the main highway between St. John and Fredericton.—EDITOR].

I have taken opportunity to look over the sections of some rocks gathered last summer, and send a few notes on them for the Natural History Society [of New Brunswick].

1. Barlow's Bluff granite.

A coarse grained grano-diorite (Tonalite). The thin section shows much quartz, orthoclase and plagioclase in about equal amounts, occasional green hornblendes, slight zonal tendency in a few of the feldspars. The hand specimen shows a few idiomorphic quartz crystals, but no trace of these appears in the section examined.

This rock is entirely of the type of the post-Laurentian granites at St. John, and belongs probably to the same series of intrusions.

2. Hornblende Basalt. From the heavy dyke in Cambrian slates back of Barlow's Bluff.

Augite and brown basaltic hornblende crystals, the former younger, with a little quartz and considerable plagioclase, much decomposed. No marked diabase structure. Considerable secondary green hornblende chlorite and calcite.

3. ? Feldspathic Diabase. Fine grained. From the centre of smaller dyke in Cambrian slates, same locality as No. 2.

Fine-grained, porphyritic with triclinic feldspars. Very feldspathic; the little dark silicate entirely decomposed. Porphyritic feldspars not very sharply outlined; those in the groundmass show the diabase structure, and are probably a not very basic labradorite.

4 & 5. Augite porphyrite. From near edge of smaller dyke, locality same as the last.

Fine grained, the porphyritic crystals decomposed but having the outlines of augites, in a groundmass of minute idiomorphic augites, and lath-shaped feldspars with flow structure. The augites of the groundmass are sharply outlined, not decomposed, and very pretty.

6. *? ? Tachylite* (basic glass). Locality same as the last, from a small branch dykelet.

Very fine grained, with a few small crystals in a decomposed base, traversed with numerous cracks doubtfully perlitic, hence perhaps a devitrified glass.

Nos. 2–6 are none of them the usual style of the Huronian diabases, although No. 3 is technically a diabase; a more complete knowledge of the dyke would, perhaps, show it to be normally an augite-porphyrite. I am inclined to think that the usual type of the post-Cambrian dykes will be found to be *augite porphyrite* and *basalt*, that of the pre-Cambrian ones either *diabase*, connected with the " Huronian " rocks, or *diorite porphyrite*, connected with the intrusive granite-diorites. No. 2 may be a later dyke than 3–6 ; it had somewhat that appearance in the field, and is fresher in section.

No. 78–187. *Dolerite.* Devil's Back.

Coarse-grained, with crowded porphyritic crystals of augite in a groundmass of small augites and feldspars.

The large augites are very much zonally cracked — no variation in composition in the different layers, so that I take it to be the result of sudden cooling in a rock half solidified. The cooling was accompanied and followed by some motion of the mass, which caused the crystals to break up more or less.

This tallies with note on the Cambrian dykes as to composition. Though the evidence on the composition of the post-Cambrian dykes is exceedingly meagre as yet, yet it points uniformly in the one direction — that of a community of origin.

69–76. *Aplite* (fine grained granite). ?"Ox-bow Reef," first rock next granite.

A granular mixture of orthoclase, quartz and secondary epidote. Occasional zircons, a little magnetite. Orthoclase tends to be idiomorphic. No plagioclase observed.

This is a peripheral phase of an orthoclase granite. It would be an interesting point if the Devonian granites should prove to be prevailingly orthoclase granites, as the post-Laurentian ones at St. John are certainly dioritic granites [called syenite and granite in Reports of the Geological Survey of Canada].

72–15. Felsite—Between the granite quarry and Vanwart's.

Fine grained, rather basic igneous rock, with lath-shaped feldspars, partly plagioclase ; a few phenocrysts, light and dark, but entirely altered so that they are not recognizable. A little quartz in the groundmass.

This may possibly be a dyke or extreme peripheral phase of the granite, but I could not say on the evidence. It appears originally to have been a fine-grained trachytic rock, with a good deal of plagioclase. I expect that a good deal of information as to their origin may be had from some of those unexamined crystalline rocks at the borders of the Devonian granites. They should present a class of contact phenomena considerably different from those of the post-Laurentian granites.

ARTICLE IV.

TIDAL PHENOMENA OF THE ST. JOHN RIVER AT LOW SUMMER LEVEL.

BY A. WILMER DUFF, M. A.

(Read March 2nd, 1897.)

I. FREE AND FORCED VIBRATIONS.

The waters of the earth have two somewhat different kinds of motion. There are, first, the steady motions, such as the Gulf Stream, caused ultimately by the heat which we receive from the sun. Secondly, there are motions of vibration, including waves of various kinds and tides. This second class also admits of an important sub-division. Firstly we have those motions of vibration whose rates are determined merely by the properties of water (especially its mass) and by its weight, or the force which the earth exercises on it; these motions being analagous to the motion of a pendulum, whose rate is determined by its length and the earth's attraction. This kind of vibratory motion we may call the *free* or natural vibrations of the water. But there is a second class of motions of vibration whose rates are determined by the motions and attractions of bodies beyond the earth, especially the moon and sun. These motions we may call the *forced* or artificial vibrations of water masses. When we speak of tides, we are inclined at first to think of them as merely forced vibrations; but, in reality, the forced vibrations give rise to free vibrations and the two kinds of vibration are quite inseparably mixed up in tidal phenomena. For instance, the highest authority on tides (Lord Kelvin) regards the tides of the English Channel as mostly a free vibration of the water, see-sawing or teetering about a line passing from Portland to Havre; and William Ferrel (probably the chief authority in America) thinks that the tides of the deep water of the North Atlantic may be an eastward and westward swinging motion, like the "wish-wash" of water in a wash-bowl. In one case only have we a motion of vibration that belongs to one only of these two classes, namely, the case of moderate sized lakes; for their motions are nearly altogether free vibrations, and it is only in very great lakes that forced vibrations can be discovered; for instance, the tides of Lake Michigan only amount to between two and three inches.*

II. Tides in Rivers.

Remembering this distinction between free and forced vibrations, let us apply it to the case of a river. Are there any forced vibrations in rivers; that is, any motions produced by the direct attractions of sun or moon on the waters of the rivers? Reason will be adduced later for believing that, in the case of the St. John river at least, there is nothing such; but it cannot be denied that in the case of a very large river like the Amazon, whose course is directly east and west, there may be such a direct forced vibration. But there is in most rivers that enter the ocean a *secondary* forced vibration; that is, a fluctuation of the level of their waters produced by a periodical rise and fall of the level of the ocean at the mouth. This distinction is sometimes put in this form, that there is no true tide in the St. John river, only a "backing-up;" but such a way of putting it is hardly justifiable. It is true that as the level of the water at the mouth rises, the speed of the stream must decrease, and as there is still practically the same supply of water from the parts of the river farther up, the level must in consequence rise progressively up stream. This is what is meant by a "backing-up." But there is also a flow of salt water up stream for a considerable distance from the mouth, a flow that differs in no respect from the flow of water up the Bay with the incoming tide. Now we have seen that we cannot limit the word tide to direct forced vibrations only, for there is none such anywhere; nor can we limit the word tide to cases in which forced vibrations and free vibrations are mixed, for it is probable that in the Bay of Fundy itself we have mostly, if not altogether, a free motion of the water, started no doubt by the forcible motions imparted to adjacent parts of the Atlantic. Tides are in fact those forced motions or free motions which may be traced back ultimately to the attractions of sun and moon. And in this sense it is evident that the rise and fall in a river is a true tide. Thus the tides in the River St. John are a mixture of a "backing-up" and a flow of salt water upwards, but this flow of salt water never extends to anything like the distance at which the "backing up" is perceptible. Along with these motions we have complications produced by wind effects and barometric effects. I am aware that some points in this account may be disputed, but I shall attempt to justify the statements in the course of what follows.

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* T. D. Graham, Vol. xiv., A. A. A. S., 1860.

III. The River St. John.

It will be necessary to state briefly a few of the physical features of the river which seem of most importance in the present connection. We shall only be concerned with the last ninety miles of its length. Just above Springhill (ninety miles from mouth) rapids occur. From Springhill to the mouth of the Belleisle, the general course of the river is between east and south-east, and the river is comparatively shallow and sluggish. Below this comes the Long Reach, a straight clear part of the river, the general direction of which is south-west. This ends at Westfield and the river again takes a southerly direction, enlarging greatly to form Grand Bay and receiving on the east the waters of the Kennebecasis, a large, wide tributary. Below Grand Bay, the river greatly contracts at the Narrows, expands again at Indiantown, then contracts again and meets with short "rapids" and then rushes through a short and very narrow gorge (only one hundred yards wide) into St. John harbour. The term "Falls," often applied to this outlet, more properly belongs to rapids above the outlet. The occurrence of islands is of importance. From Springfield to Oromocto few occur, from Oromocto to Oak Point they are large and numerous, and below Oak Point there are but few.

IV. POINTS TO BE ASCERTAINED.

While the St. John offers no such striking phenomena as the Petitcodiac and other streams near the head of the Bay of Fundy, yet, when its great size and remarkable outlet and the striking tides of St. John harbour are considered, it should, from the tidal standpoint, be one of the most interesting of rivers. A comprehensive study of its tides at various representative points should tells us: (1) The difference of time between high water and low water at such points and high water and low water at St. John. (2) The proportion which the range of tide bears to the corresponding tide at St. John. (3) The nature of the tidal rise and fall. (4) The effects of varying cross-section, depth, presence of islands and tributaries on the extent and time of tide. (5) The effect of the remarkable outlet. (6) The effect of varying depth of river with changing seasons on the preceding. (7) The effect of winds. There is at present practically no information, at least in print, to be had on any of the above points. To get anything like complete data, on even one of the above points, would demand much time and patience. What follows can only pretend to be somewhat disjointed information on nearly all of the above heads. It must be remembered that all of the following notes were made at low summer level. Towards the end of the summer of 1896 the river fell to a very low level. To fix the level by a semi-permanent reference point, on August 9th I found mean water level of Fredericton to be twenty-four feet two inches below the south-west corner of the west pier of the iron railway bridge. From the levellings of the New Brunswick railway, Mr. Moses Burpee found that a certain reference point at Fredericton was forty-four feet ten inches above mean sea-level at St John. Prof. Dixon has kindly aided me by levelling from Mr. Burpee's reference point to the corner of the pier mentioned, and finding the latter to be three feet four inches lower than Mr. Burpee's reference point. From this I deduce that the south-west corner of the west pier of the bridge is forty-one feet six inches above mean sea-level at St. John; and that on August 9th the mean water level at Fredericton was fourteen feet four inches above the mean sea level at St. John. These figures may be of some future use for reference, and they are given for what they may be considered worth. Exception may be taken to the use of railway levellings for such a purpose, but other data are not to be had at present. I am indebted to Dr. Harrison, of the University of New Brunswick, for Mr. Burpee's figures.

V. Tide Gauge Used.

For the purpose of the following work I used a self-recording tide gauge of a simple type designed by myself and made with the assistance of Mr. H. White of Fredericton. As a description may be of use to others I give the following brief account of it. It consisted of a float to rise and fall with the water and a vertical drum driven by a clock, the parts being so arranged that a pencil attached to the float traced a curve on a sheet of paper wrapped around the rotating drum. The details and dimensions were as follows:

The float consisted of a cylindrical can plain at the top and with a conical lower end, the lower end being loaded with shot to give the float greater stability in the water. The diameter of the can was five inches and its length without the conical end five inches, with the conical end seven and a half inches. A brass tube was soldered axially through the can. Through the tube a brass rod passed loosely so that the float might slide up and down the rod as an axis. This axis was clamped in the frame-work of the machine, so that it might be removed and cleaned. Above the rod came the rotating drum, a cylinder of wood twelve inches long and three inches in diameter. The upper end of this made friction connection with a spring clock by means of a small axial rod fastened to a brass plate which was screwed to the wooden drum. The lower end rested on a spring by means of a similar axial rod having a conical point which turned with very little friction in a conical hole in a brass plug attached to the spring. The purpose of the spring was to keep the cylinder pressed tightly against the clock. A long springy piece of brass was soldered by its lower end to the side of the float and its upper end carried a pencil which pressed lightly against the cylinder. It is easily seen that surface waves might move the float and so obscure the tidal record; hence the whole instrument was enclosed in a long, narrow, vertical box which leaked slightly at the bottom. Thus the water level in the box changed with the slow rise and fall of the tide but surface waves had no effect. The machine was held at the proper level in the water by being solidly clamped to an iron stake driven in the ground.

In preparing for an observation, a sheet of white paper was wrapped around the cylinder. The cylinder was then put in place and the pencil arranged so as to press against it. The exact time of beginning and ending the record being noted, the time corresponding to any particular point on the curve could be deduced after the paper was removed.

VI. CURVES OBTAINED AT SPRINGHILL.

The first point at which this instrument was used was immediately above the rapids above Springhill on July 21st and 22nd. The line traced in twenty-four hours indicated a fall of thirteen-sixteenths of an inch, but differed by less than one-sixteenth of an inch from a straight line, indicating that absolutely no tides are propagated above these rapids, at least along the right bank. The next point chosen was just below the rapids, about a quarter of a mile above the Springhill hotel. A twenty-seven hour record was taken on July 23rd and 24th. This showed in a remarkable way an effect frequently afterwards noticed, the great influence of wind. From 6.30 p. m. to 9 p. m. of the 23rd, a strong wind blew down stream, and during this time the pencil traced almost a straight line. At 10.30 it rose about a quarter of an inch, and then fell smoothly to low water at 3 a. m., and rose to high water at 8 a. m.; the range from high water to low water being four and a half inches. The instrument was then removed to be slightly altered, and at 8 p. m. of July 28th it was replaced at the same point, and thenceforward a continuous record was obtained until August 6th. This would have given eighteen high waters and seventeen low waters, were it not for the fact that the weather, which, until the 31st, was calm, suddenly became stormy, with winds of as much as twenty miles an hour from the north-west, that is, from nearly exactly up-stream. These were sufficient to totally obliterate the ordinary tidal rise and fall and give curves whose ragged irregularities represented faithfully every variation in speed and direction of wind. In the complete record which accompanies this I may point especially to 7 p. m. of the 4th, 8 a. m. of the 5th, 1 p. m. of the 30th, and 1 a. m. of the 2nd. The corresponding wind velocities, kindly supplied by Dr. Harrison, have for comparison been placed at the top of the record. A curious hump in the curve at 10 p. m. of the 5th was explained by a sudden gust of wind which, Dr. Harrison informed me, was indicated by the recording wind gauge just at that time. These facts are interesting as indicating the very great effect which wind has on water in a somewhat confined basin. The effect would, of course, be still more marked in the case of lakes. This is of interest in connection with the other paper (on secondary undulations) presented to the Society.

The smoothness of the curves in calm weather is of importance as indicating that we have at Springhill no true forced vibration of the water, produced directly by lunar influence, but only a free derived waved started by the rise and fall at St. John. A mixture of both would give irregularities in the curve.

VII. TIME AND AMOUNT OF HIGH WATER AT SPRINGHILL.

In the curves obtained at Springhill, there are in all twelve fairly well marked high waters, the others being unreliable on account of wind disturbances. Of these, six were obtained during very calm weather and six others during windy weather. From the former, Table I has been calculated. Column 2 gives the range of tide at Springhill, 3 the range of tide at St. John, 4 the percentage of the St. John tide that reaches Springhill, 5 the difference between the time of high water at Springhill and high water at St. John, 6 the difference of the time of low water at Springhill and low water at St. John. The times of high water at St. John were obtained from the records of the Kelvin Recording Tide Guage, for access to which I have to thank

TABLE I.

Time and Amount of Tide at Springhill.

Date.	Range at Springhill.	Range at St. John.	Percentage at Springhill	Difference of times of H.W. at Springhill and St. John.	Difference of times of L. W. at Springhill and St. John.
July 23	4.5 in.	22.1 ft.	1.70	9 h.—19m.	11h.—49m.
28	3.94 "	20.4 "	1.61	9 h.—15m.	11h.—18m.
29	4.12 "	20.0 "	1.72	9 h.—18m.	10h.—57m.
30	4.25 "	20.6 "	1.72	9 h.—30m.	11h.— 3m.
30	3.62 "	19.6 "	1.54	9 h.—15m.	10h.—45m.
31	3.32 "	18.1 "	1.52	9 h.—20m.	....
Mean	3.96 in.	20.1 ft.	1.63	9 h.—20m.	11h.—9m.

TABLE II.

Time and Amount of Tide at Springhill.

Date.	Range at Springhill.	Range at St. John.	Percentage at Springhill	Difference of times of H. W. at Springhill and St. John.	Difference of times of L. W. at Springhill and St. John.
Aug. 3	4.06 in.	16.25 ft.	....	9h.— 9m.	10h.—45m.
4	4.32 "	14.55 "	....	9h.—28m.	11h.—10m.
4	4.19 "	16.4 "	....	9h.—20m.	11h.—55m.
5	2.87 "	15.0 "	....	9h.—36m.	11h.—50m.
5	3.00 "	15.0 "	....	9h.—1 m.	11h.—13m.
6	....	18.0 "	....	9h.—5 m.	11h.—20m.
Mean	....	15.9 ft.	....	9h.—16m.	11h.—22m.

Mr. D. L. Hutchinson. Table II is similar to Table I, except that it is calculated from the less reliable results obtained during windy weather. The following are the more important points brought out by these tables:

(1) *The Time of High Water at Springhill.* Just at high water or low water at any place the level changes very slowly. Hence it is difficult to be quite certain of the exact moment of change. Remembering that this remark applies to both the St. John and the Springhill records, the close agreement among the results of column 5, which gives the interval between high water at Springhill and high water at St. John, must be considered very satisfactory. The mean interval is nine hours and twenty minutes, the greatest divergence from the mean is ten minutes, and the next greatest five minutes. The "probable error" is only one and a half inches. The second series being made in windy weather, do not agree so well among one another, but give a mean of nine hours and sixteen minutes, differing by less than one per cent from the preceding. The mean tidal range at St. John was twenty feet in Series I and sixteen feet in Series II. Hence the former results may be taken as fairly representative of spring tides and the latter as neap tides. The mean tidal range is twenty-five per cent greater in Series I than in Series II, and yet the time of passage of high water from St. John differs by less than one per cent. We seem justified in concluding that the interval between high water at St. John and high water at Springhill is practically independent of the tidal range. This should be remembered in connection with the results obtained at other points on the river.

(2) *Amount of Tide at Springhill.* From Series I we see that when the mean range of tide at St. John is twenty feet, that at Springhill is four inches or 1.63 per cent or about one-sixtieth of the range at St. John. Moreover, the range at Springhill is (allowing for wind disturbances) proportional to that at St. John. This is otherwise evident from the principle of the superposition of small motions.

(*3*) *Time of Low Water at Springhill.* From Table I it is seen that low water at Springhill occurs on an average eleven hours and nine minutes later than low water at St. John. Hence it takes low water one hour and of rty-nine minutes longer to travel from St. John to Springhill than it does high water. This is shown in another way by the shape of the Springhill curves. It will be noticed that in all cases the curves are steeper on one side of high water than on the other, the tide rises faster than it falls, so that a low water always comes closer to the succeeding high water than to the preceding. In fact, the average time from low water to high water is only five hours and seventeen minutes, while that from high water to the next low water is seven hours and seven minutes. This relative delay of low water is due to one of the differences between wave motion in a shallow river and wave motion on the ocean. In the former the more elevated parts of a wave always travel faster than the less elevated or the depressed parts. In fact, if v be the velocity of any part of a wave whose elevation above the mean level is h, and if H be the depth of the river

$$v=c\left(1+\frac{3}{2}\frac{h}{H}\right)$$

In this, c is of course the value of v, for parts of the wave for which h is zero; that is, for parts of the wave midway between crest and trough. In the parts of the wave below mean water level h is negative. Hence v is greater for the crest than for the trough; that is, greater for high water than for low water. Thus low water keeps lagging farther and farther behind the high water ahead, and approaching the high water behind. This process may go so far that the front of the tide wave becomes nearly vertical and then we have a bore as in the Seine, Petitcodiac and many other rivers.

With this greater steepness of the front of the tide wave another peculiarity is often developed. The rear slope of the wave may first become straight and then actually recurved. This is hardly shown in any marked degree on the St. John River, although the rear slope sometimes approximates to a straight line. The depth of the river decreases too gently and uniformly to show these more marked features often shown in tidal rivers.

VIII. Form of Tide Wave at St. John.

While the change of form referred to in the preceding is a well known feature in rivers, I do not know that attention has ever been called to the fact that the same thing may happen even in large bays like the Bay of Fundy. It occurred to me to examine carefully the tide record at St. John to see if low water falls exactly midway between two high waters. Table III gives the time from high water to low water and from low water to

Table III.

Delay of Low Water at St. John.

Time from H.W. to L. W.	Time from L. W. to H.W.	Delay of L. W.	Time from H.W. to L.W.	Time from L.W. to H.W.	Delay of L. W.
hrs. min.	hrs. min,	min.	hrs. min.	hrs. min	min.
6 — 25	6 — 10	7.5	6 — 10	6 — 5	2.5
6 — 20	6 — 5	7.5	6 — 30	6 — 2	14.0
6 — 33	5 — 59	16.0	6 — 11	6 — 12	—0.5
6 — 10	6 — 0	5.0	6 — 22	6 — 3	9.5
6 — 13	6 — 9	2.0	6 — 30	6 — 0	15.0
6 — 33	5 — 57	18.0	6 — 15	6 — 0	7.5
6 — 25	5 — 55	15.0	5 — 16	6 — 6	5.0
6 — 33	5 — 53	20.0	6 — 18	6 — 2	8.0
6 — 15	6 — 0	7.5	6 — 23	6 — 5	9.0
6 — 18	6 — 0	9.0	6 — 23	6 — 0	11.5
6 — 24	6 — 3	10.5	6 — 22	6 — 5	8.5
6 — 18	6 — 10	4.0	6 — 30	5 — 58	16.0
6 — 13	6 - 7	3.0	6 — 30	6 — 10	10.0
6 — 18	6 — 12	3.0	6 — 25	6 — 2	11.5
6 — 8	6 — 7	0.5	6 — 28	6 — 17	5.5
6 — 13	6 — 20	3.5	6 — 18	6 — 10	4.0
6 — 22	6 — 10	6.0	6 — 20	6 — 2	9.0
6 — 18	6 — 10	4.0	6 — 13	6 — 5	4.0

Mean delay, 8 min.

high water for all the tides in a month whose exact time of high water to low water could be read accurately enough to be the basis for an estimate. Out of the thirty-six complete tides there recorded, thirty-four show a greater length of time from high water to low water than from low water to high water. The mean delay of low water is eight minutes, or the time from high water to low water is on the average sixteen minutes greater than the time from low water to high water. It should be noted that this delay of low water in St. John harbour is not due to the fact that the harbour is at the mouth of a large river; this would tend to have exactly the opposite effect. For, shortly before low water would naturally occur, the inflow from the river neutralizes the outflow into the bay and thus causes the tide to turn earlier or the low water to come earlier. On the other hand, the upflow into the river just before high water would occur neutralizes the inflow from the bay and so causes high water to occur earlier. Now if high water and low water were thus hastened equally, there would be no change in the time from high water to low water or from low water to high water. But since on the whole there is a greater downflow from the river than upflow into it, it is clear that the river must hasten low water in the harbour more than it hastens high water. Hence we may conclude that did the river not exist, the delay of low water in the harbour would be slightly greater than eight minutes. No doubt part of this delay must occur whilst the tide is passing from Mispec Point inward. How much of it occurs during the passage of the tide up the bay must remain an open question.

IX. RESULTS AT OTHER POINTS ON RIVER.

The observations made at other points are given in Table IV and summarized in Table V. These tables show at Springhill, Fredericton, Oromocto, Gagetown, Oak Point, Westfield and Indiantown, (1) the mean spring-range (it being assumed that the spring-range at St. John is twenty-seven feet); (2) how much later high water is at each point than at St, John; (3) how much low water is delayed compared with high water. The last column of Table V seems to show that between Indiantown and Oak Point the low water is delayed over twenty minutes compared with high water; between Oak Point and Oromocto low water travels as fast as high water, and between Oromocto and Springhill low water again loses half an hour.

TABLE IV.

Place.	Date.	Tide in Inches.	St. John Tide in feet.	Percentage of St. John Tide.	H. W. later than at St. John.	L. W. later than at St. John.
					hr. min.	hr. min.
Fredericton...	July 24	5.3	22.1	2.0	8 — 39	10—17
	Aug. 21	5.6	19.5	2.4	8 — 47	10—49
	" 22	6.1	22.1	2.3	8 — 59	10—3
Oromocto....	" 10	6.6	24.5	2.2	8 — 0	8—48
	" 11	7.9	25.7	2.6	7 — 55	8—24
Gagetown ...	" 11	9.1	25.1	3.0	5 — 42	6—20
	" 12	9.6	25.5	3.1	5 — 37	6—13
Oak Point ...	" 12	12.0	25.2	4.0	3 — 18	3—57
	" 13	13.8	24.6	4.7	3 — 11	4—7
Westfield	" 14	18.5	23.5	6.5	2 — 26	3—18
	" 14	......	23.6	.....	2 — 32	......
Indiantown	" 31	16.0	16.6	8.0	2 — 2	2—5

TABLE V.

Place.	Distance from Indiantown.	Mean Spring Range.	Mean Percentage of St. John Range.	H. W. later than at St. John.	Delay of L. W.
				hr. min.	min.
Springhill	90	5.2	1.6	9 — 20	55
Fredericton	83	7.1	2.2	8 — 45	49
Oromocto	73	7.8	2.4	7 — 57	20
Gagetown	48	9.7	3.0	5 — 40	24
Oak Point...	25	13.9	4.3	3 — 15	24
Westfield.........	10	21.0	6.5	2 — 30	24
Indiantown	0	25.9	8.0	2 — 2	0

X.—RATE OF PROGRESS OF HIGH WATER UP RIVER.

To show the speed with which high water travels up river I have plotted the results on cross section paper. Indiantown is taken as origin or starting point. Times after high water at Indiantown are represented by horizontal lines or abscissæ, and the distances which high water has progressed in those times are represented by vertical lines or ordinates. The points on this chart corresponding to the seven stations of observation are joined by straight lines. The slope of this broken curve at any point represents the speed of the high water at that point. This shows at a glance that, whereas the speed is much less between Oak Point and Oromocto than it is between Indiantown and Oak Point, it increases again between Oromocto and Kingsclear. In fact the average speed of high water is:

Between Indiantown and Oak Point — 20 miles an hour.
" Oak Point and Gagetown — 9½ " "
" Gagetown and Springhill — 11½ " "

It is interesting to compare this with the fact, stated in the preceding section, that the delay of low water is greatest between Indiantown and Oak Point, and between Oromocto and Springhill, but is at least very small between Oak Point and Oromocto. Again both of these statements seem connected with the fact noted earlier that it is between Oak Point and Oromocto that islands are numerous and greatly interrupt the course of the river. Hence we seem justified in concluding that irregularities and obstacles in a river retard the progress of high water, but do not delay low water as compared with high water.

I have also plotted a curve representing how the amount of tide from point to point of the river varies with the distance from Indiantown. Excepting the highest point, Springhill, the points lie roughly on an exponential curve, indicating that each mile produces roughly the same percentage decrease of tidal rise. This would seem almost obvious beforehand, and need hardly be discussed further.

XI. Time of High Water at any Point on River.

The broken curve connecting times of high water at the seven points of observation and their distances from Fredericton enables us, given the distance of any point whatever from Indiantown, to find how much later high water occurs at that point than at St. John. We have only to find the point on the curve whose ordinate is the distance from Indiantown, then the abscissa of that point is the time its high water occurs later than the time of high water at Indiantown. Now a knowledge of the exact time at which high water may be expected at any point is (at least so residents along the river frequently informed

Table VI.

Time of High Water at various points.

Distance from Indiantown.	Name of Place.	H. W. later than H. W. in St. John Harbor.	Intermediate Points.
		hrs. min.	
0	Indiantown.	2 — 4	To column 3 add 3 minutes per mile
10	Westfield.	2 — 29	
17	Pitt's Landing, (Devil's Back).	2 — 50	
25	Oak Point.	3 — 15	
29	Mouth of Belleisle, (Palmer's Point).	3 — 40	To column 3 add 5 minutes per mile
33	Hampstead.	4 — 6	
37	Mouth of Washademoak.	4 — 31	
42	Slipp's Wharf.	5 — 3	
48	Gagetown.	5 — 40	
50	Jemseg, mouth of Grand Lake.	5 — 52	
56	Charles Gunter's.	6 — 25	
60	Upper Gagetown.	6 — 46	
64	Sheffield.	7 — 10	
71	Maugerville.	7 — 48	
73	Oromocto.	7 — 57	
83	Fredericton.	8 — 45	
90	Springhill.	9 — 20	

me) a matter of considerable importance especially as regards setting nets for fishing, getting grounded vessels afloat and other such practical purposes. Hence, although my motive in this enquiry has been purely scientific interest, I have thought it worth while to give in Table VI the interval between high water in St. John harbor and high water at seventeen points of importance on the river. This table, together with a McMillan's Almanac, will enable a resident on the river to anticipate high water quite as accurately as a resident in St John can at the present time; for the figures in Table VI cannot be more than ten or twelve minutes in error, probably much less, and this is a smaller amount than the error incident to the prediction of high water in St. John harbor at present. It may be well to repeat that this table applies to either spring or neap tides during low summer level. It remains to be seen whether it will apply to the river when full, in the spring or early summer. I think it can be safely predicted that the difference will not be great; for, while the greater speed of the water will naturally retard the progress of high water, the greater depth of the river will cause a wave, whether up or down, to travel with greater speed; and the two effects, depending on the same cause, will tend to neutralize one another. This, however, is a point that should be settled by observations in springtime.

XII. Effect of Narrow Outlet of River.

The most important tidal effect due to the remarkably narrow outlet of the river is the great delay of high water at Indiantown—two hours very closely,—although Indiantown is only a mile from the harbour. As the water rises in the harbour it must attain the level in the river above the rapids before much rise can occur at Indiantown. After that, as the supply of water from the harbor and bay is unlimited, while the large basins above Indiantown have a great capacity, the narrow outlet under the bridge is totally inadequate to keeping the levels above and below equal, so that for two hours after the water has reached its maximum level at St. John, and has begun to fall, it is still running up river. At low water the converse happens, that is, the level at Indiantown keeps falling nearly until the part below the rapids has been filled up to the level above the rapids. It seems, however, not a little remarkable that the delay is so exactly the same for high water and low water. This account must be admitted to be very imperfect, as I had very little time for exact observations, except as regards the time of high water and low water at Indiantown.

XIII.—Tidal Currents.

In the preceding I have not paid any attention to the currents which form so important a part of tidal phenomena. The subject is one of great complexity in such a river as the St. John. Two remarks may however be made.

First it is rather a common mistake to suppose that there must exist a flow of saltish water as far up the river as tides can be detected. Two grounds are sometimes advanced for this view. The first is that a tide means a flow of water and there must be a flow of water as far up as there is a tide. This statement is true, but the deduction is unsound; for a tide, whether in a river or on the ocean, is a wave, and a wave may pass on for thousands of miles while the water at any place only makes short excursions, going forwards as the crest of the wave passes by, and backward as the trough passes. No one would claim that the water at the mouth of the Bay of Fundy travels the whole way to the head with the tide, for if so a vessel could float that distance in one tide. The second ground sometimes advanced is that there must, by the principles of hydrostatics, be salt water as far up steam as the point at which the bed of the river is on a level with the mean level of salt water at the mouth of the river; and that hence up to the head of the tides there will be an undercurrent of salt water up and an overcurrent of fresh water down. But it is impossible that two such layers should co-exist for a hundred miles without mixing. Again in many rivers such as the Amazon, La Plata, and Forth it is known that the tides extend a long distance further up than the point at which the level of the bed of the stream is the mean water level at the mouth.[*] But even without this the evidence is complete; for I have obtained specimens of water from both surface and bottom at Fredericton and Indiantown at high water and their specific gravities reduced to 0° C. I find to be

Fredericton,	Surface water, ...	1.0005
	Water from bed,....	1.0003
Indiantown,	Surface water, ...	1.0054
	Water from bed,....	1.0109

Thus to within one-fiftieth of one per cent the water at Fredericton has the same density at surface and bottom. Even at Indiantown the process of mixing of salt water and fresh water is well advanced, for the density of the surface water is raised to 1.0054, and that of the bottom is lowered from about 1.026 which is the average density of sea water to 1.0109. When the diffusion has proceeded thus far even at Indiantown, it is evident that the tide will not have progressed many miles up river before the mixing is practically complete. How far salt water actually does travel up stream cannot be stated. It has been known as far as Gagetown.

As regards the amount of tidal current, I may note that on the morning of Monday, August 4th, I saw at Oromocto a log float one and a quarter miles up stream in the main channel in two and a half hours. That was at high water of a spring tide. That it was an unusual amount of up-current was evident from the extent to which it seemed to puzzle a ferryman. Also at Fredericton on Aug. 22nd, at 4 p. m., I observed a feeble current up. A careful examination of this whole question would be of great importance in such discussions as to whether the discharge of sewage into the river below Fredericton could affect the waterworks above the city.

In conclusion I wish to express my indebtedness to Mr S.W. Kain and Mr. Percy G. Hall, of the Natural History Society, also to Mr. Thomas Loggie, of Fredericton, Professor Davidson, of Fredericton, and Mr. E. T. P. Shewen, of St. John, besides the gentlemen previously mentioned, all of whom have been so kind as to supply me information or assistance.

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[*] See Young's General Astronomy, p. 477. Airy's Article, Tides and Waves—Ency. Metropolitana.

BIBLIOGRAPHY OF SCIENTIFIC PUBLICATIONS RELATING TO THE PROVINCE OF NEW BRUNSWICK OTHER THAN THOSE CONTAINED IN THE BULLETINS OF THE SOCIETY, 1897.

BY SAMUEL W. KAIN.

Lists similar to the one here given will be found in Bulletins XIII–XIV. They contain titles from 1890 to December, 1896. The present list contains titles from January, 1897, to June, 1897.

GEOLOGY.

MATTHEW, G. F.—The Oldest Siphonotreta. *Geological Magazine*, No. 392, New Series, Decade IV, Vol. IV, No. 11, pp. 68–71, February, 1897.

Some Features of the early Cambrian Faunas. *Report of the British Association for the Advancement of Science*, 66th meeting at Liverpool, 1896; pp. 785–787.

Some Features of the early Cambrian Faunas (Abstract). *Science*. New Series, V, pp. 254–256, February, 1897.

What is the Olenellus Fauna? *American Geologist*, Vol. XIV, No. 6, pp. 396–407, June, 1897.

SIMONDS, FREDERICK W.—Professor Charles Fred. Hartt, M. A. A tribute. *The American Geologist*, Vol. XIX, No. 2, pp. 69–90. February, 1897.
(Portrait and list of Prof. Hartt's writings).

PHYSIOGRAPHY.

GANONG, W. F.– On the Heights of New Brunswick Hills, *St. John Daily Sun*, May 10th, 1897.

On the Colors of the Waters in New Brunswick. *St. John Globe*, May 15th, 1897.

Dalhousie and St. Andrews—a Coincidence. *Daily Sun*, (St. John, N. B.,) June 4th, 1897.

DUFF, A. WILMER.—*Seiches* on the Bay of Fundy (Abstract). *American Journal of Science*. Fourth Series, Vol. III, No. 17, pp. 406–412. May, 1897.

THIRTY-FIFTH ANNUAL REPORT

OF THE

COUNCIL OF THE NATURAL HISTORY SOCIETY

OF NEW BRUNSWICK.

The Council of the Natural History Society beg leave to submit the following report for the year now ending:

MEMBERSHIP.

The Society has added to its roll thirty-six members, viz.:

Honorary (Professor John E. Marr)	1
Ordinary	14
Associate	16
Honorary Associate	2
Corresponding	3
Total,	36

Our membership now consists of:

Life Members	7
Honorary Members	4
Ordinary Members	61
Corresponding Members	36
Associate Members	57
Honorary Associate Members	2
Total	167

While a very satisfactory increase has been made, we look for still greater additions when citizens realize that it is their duty as well as privilege to assist in the support of a public institution such as ours.

During the year the Society has lost through death two patrons, one ordinary and one corresponding member.

Sir Samuel Leonard Tilley was patron during his two terms as Lieutenant Governor of the province, and an ordinary member up the time of his death, which occurred last June. In his death the Society sustained the loss of one who took a great interest in its work, while the community in which he lived, and the Dominion at large, lost the services of a wise and enlightened statesman.

Honorable John James Fraser, who held the office of patron during the short term of his Lieutenant Governorship, died at Genoa, where he had gone for the benefit of his health.

In the death of Alex. Munro, C. E. (Port Elgin), and William F. Bunting, we lost members of long standing.

FINANCE.

The Treasurer makes the following statement:

Balance from 1895,	$ 61 74
Government grant,	125 00
Fees collected,	109 00
Interest on investment,	144 00
Bulletins sold	2 00
Donation (J. W.)	2 00
Dividend Botsford Estate	10 00
Dividend Maritime Bank	3 38
	$457 12
Expenditure	450 68
Balance	$6 44

LIBRARY.

The Library has grown rapidly,— the result of a greatly extended exchange list. We have thus been able to provide for our members the latest information in many branches of research; and while we cannot say that full use of this opportunity has been made, the advantage still exists for those who are interested in scientific progress.

The Lords Commissioners of Her Majesty's Treasury have presented to the Society a complete set of the "Challenger" Reports, which will be of great value to our members.

As practically nothing has been done lately in cataloguing the library, we trust that our next librarian, with his assistants, will be able to give the time necessary to perform this important work.

PUBLICATIONS.

Bulletin XIV has been published. It contains articles by G. W. Gesner, G. U. Hay, and W. F. Ganong. Arrangements have been made to reprint Bulletin III, which has long been out of print. Several copies of Bulletin I having been secured, the Society will soon have a number of complete sets of Volume I.

LECTURES AND ESSAYS.

Eight regular meetings were held when the following papers were read :

1896.		
Feb.	4.	The Old Meductic Fort. By Rev. W. O. Raymond. (Published in Collections N.B. Historical Society. Vol. 1, No. 2, pp. 221-272, 1 map, 2 pl., 1896.)
Mar.	3.	Some results of the "Challenger" Expedition. By Geo. F. Matthew.
April	7.	(1) Life of Dr. Abraham Gesner. By G. W. Gesner. (Published in Bulletin XIV.
		(2) The Tantramar Marsh. By Geo. J. Trueman.
May	3.	(1) Notes on two Shrews new to New Brunswick. By Philip Cox. (Published in Bulletin XIV.)
		(2) Recent Additions to the List of New Brunswick Fishes. By Philip Cox. (Published in Bulletin XIV.)
		(3) Addresses on the "Challenger" Expedition. By Geo. F. Matthew, Samuel W. Kain and H. G. Addy.
June	2.	(1) Adaptations of Plants to Reproduction, including Locomotion of Pollen. By W. F. Ganong. (Published in Bulletin XIV.)
		(2) The Outlet-Delta of Lake Utopia. By W. F. Ganong. Published in Bulletin XIV.
		(3) On Artesian Wells. By Geo. F. Matthew.
		(4) The Pottery of the Cliff-Dwellers. By Samuel W. Kain.
Oct.	6.	Wild Berries of New Brunswick. By Walter S. Butler.
Dec.	1.	The Restigouche — With Notes on its Flora. By Geo. U. Hay. (Published in Bulletin XIV.)
1897.		
Jan.	5.	(1) The Oldest Siphonotreta. By Geo. F. Matthew. (Published in Geological Magazine.)
		(2) The Cambrian System in the Kennebeccasis Valley. By Geo. F. Matthew.
		(3) Upon Temperature-Measurements with the Thermophone in Clear Lake. By W. F. Ganong. (Published in Bulletin XIV.)

The following elementary lectures were delivered:

1896.

Jan.	Eygpt. By Emma C. Fiske.
Feb.	The Microscope. By Dr. W. W. White.
Mar.	On Plants. Geo. U. Hay.
Apr.	On Birds. Philip Cox.
Sept.	Habits of Birds. W. Albert Hickman.

MUSEUM.

The birds have received considerable attention from Messrs. W. A. Hickman and Alfred Morrisey. Dr. Philip Cox, John Moser and W. A. Hickman made use of the museum in their work last summer.

The archæological collection in Case No. 1 was re-arranged and catalogued, and further reforms in the labelling are contemplated. The Committee on Archæology report several accessions. The Field Columbian Museum sent twenty-three pieces of prehistoric pottery in exchange for Devonian fossils; the Director of the U. S. National Museum sent a collection of casts of prehistoric weapons, ornaments, etc., and Judge DesBrisay of Bridgewater, N. S., donated some fragments of pottery from Nova Scotia.

GEOLOGY.

The report of the Committee on Geology describes some researches made by the Messrs. Matthew in the Cambrian rocks of the Long Reach and Kennebecasis Valleys.

BOTANY.

The Botanical Committee report that a preliminary list of the New Brunswick mosses had been prepared by Mr. John Moser which will be published in the Bulletin at an early date.

A number of flowering plants new to the province were found by W. F. Ganong and G. U. Hay in their trip down the Restigouche. These were published in Bulletin XIV.

ECONOMICS.

The Council have drawn the attention of the Department of Public Works of Canada to the desirability of establishing in the Dominion a plant for creosoting timber. The creosoted timber used in the construction of public works in the Maritime Provinces is at present imported from the United States at large expense. The process, too, by which this timber is treated is not reliable, and the Department has been recommended to adopt the Boulton process. A paper on this subject by E. T. P. Shewen, Esq., C. E., which was read before the Society, has been published by the Public Works Department in the Report of 1896.

GENERAL.

Two field meetings were held—one at Ingleside, the summer residence of President Hay, the other at Red Head, the summer residence of Vice-President H. G. Addy. Both were largely attended. The first had a decided advantage in point of weather; the second was rendered less pleasant by heavy rains which set in shortly after luncheon and continued all the afternoon.

In September last, Dr. Geo. F. Matthew attended the meeting of the British Association at Liverpool, G. B., where he read a paper on the Early Cambrian Faunas. On his return the Society tendered him a reception which was much enjoyed by the members and their friends. The Council take this opportunity to express their hearty appreciation of the work done by the associate members on this occasion. Nothing could exceed the energy with which the ladies entered into the room improvements, while the arrangements for refreshments were made with a degree of care which contributed greatly to the success of the reception.

The Council desire to thank the St. John press for the free insertion of notices and reports of meetings; and those who contributed papers during the year.

This report would be incomplete if we failed to express the hope that in the future we should possess rooms in which we could exhibit our collections to better advantage and extend the scope of our work. We have now nearly reached our greatest capacity, and we cannot hope to add much to our collections until our (at present utopian) new building has become a reality.

In conclusion, the Council draws your attention to the fact that the past year has been a remarkable one in many respects. Never before have the field meetings been so largely attended; the accessions to the library and membership exceed in importance those of any other year; the Museum has had many noteworthy additions; while to be represented at meetings of the British Association as this Society was last year, would be an advantage to any organization engaged in the study of Natural History.

Respectfully submitted,

PERCY G. HALL,
Secretary.

DONATIONS TO THE LIBRARY, 1896.

DONOR'S NAME.	RESIDENCE.	WORK.
Lords Commissioners of Her Majesty's Treasury	London	"Challenger" Reports, 50 Vols.
Trustees British Museum	do	Guides.
Royal Society	do	Proceedings.
Royal Colonial Institute	do	Journal.
Geological Society	do	Abs. of Proceedings.
Director Royal Gardens	Kew	Bulletins.
Manchester Geological Society	Manchester	Proceed and Trans.
Biological Society	Liverpool	do
Liverpool Geological Society	do	do
Marine Biological Association	Plymouth	Journal.
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